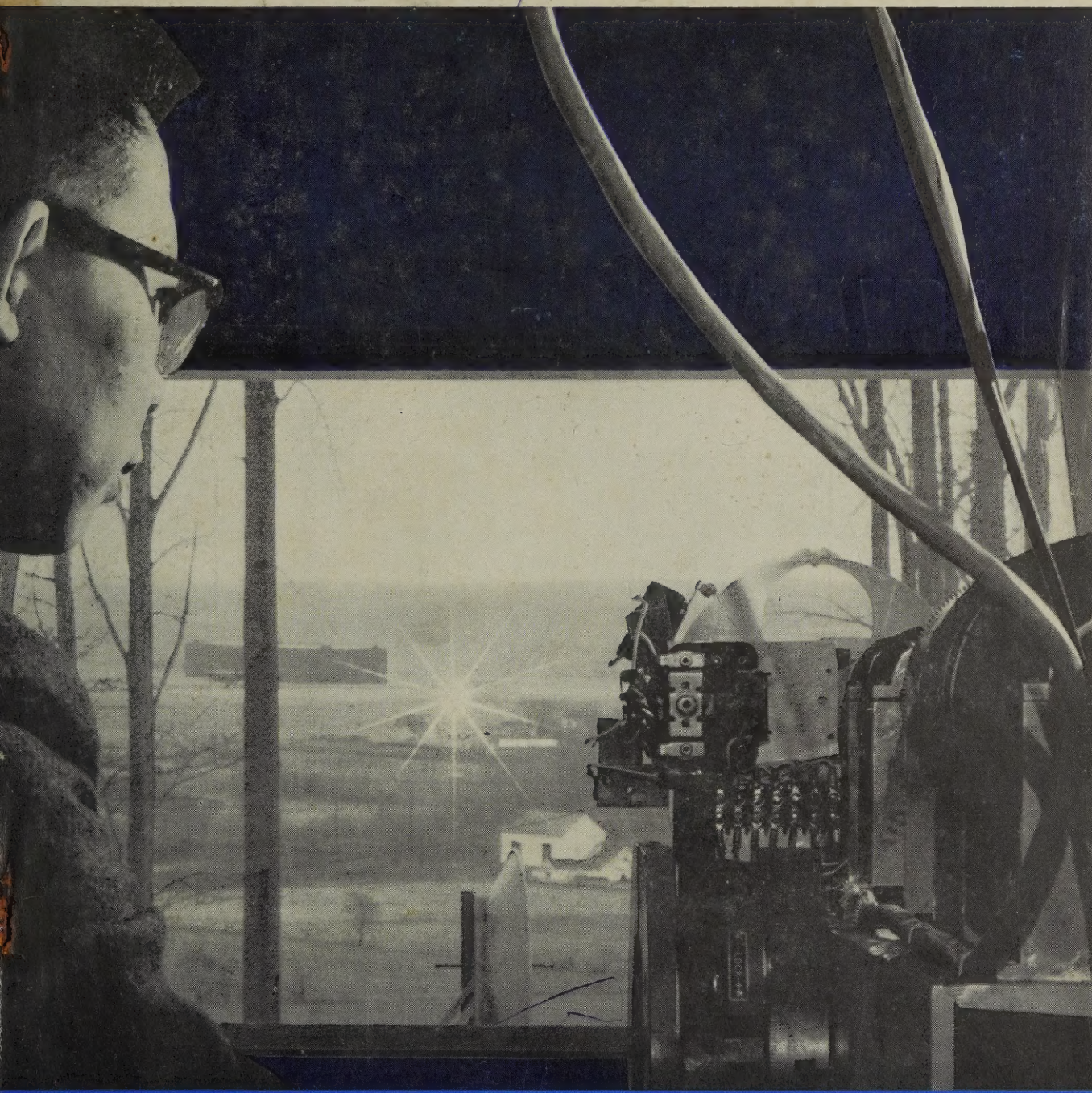
CONSTANT LUMINANCE IN COLOUR TELEVISION

- ELECTRONICS
- TELEVISION
- RADIO • AUDIO

Wireless World

NOVEMBER 1964 ~~Two Shillings and Sixpence~~ 2/9



FERRANTI PARAMETRIC AMPLIFIERS NOW AVAILABLE

*

THIS IS REALLY NEW

10% BANDWIDTH
3dB NOISE FACTOR
20dB GAIN
3000 Mc/s. WORKING FREQUENCY
TYPE/S20B

PARAMETRIC AMPLIFIERS (with constant gain/bandwidth product)

Frequency Range 215—1,650 Mc/s.

TYPE	CENTRE FREQUENCY	NOISE FACTOR	BANDWIDTH (3dB)	GAIN
VCA/L10	600 Mc/s.	1dB	8 Mc/s.	20dB
VCA/L20	1200 Mc/s.	1·5dB	10 Mc/s.	20dB
Frequency Range 1,650—3,200 Mc/s.				
VCA/S10	1,700 Mc/s.	< 3dB	30 Mc/s.	18dB
VCA/S20	3,000 Mc/s.	< 3dB	80 Mc/s.	20dB
Frequency Range 4,000—5,000 Mc/s.				
VCA/C10	4,600 Mc/s.	3·5dB	25-30 Mc/s.	20dB

FERRANTI
First into the Future

Write now for details: FERRANTI LTD · GEM MILL · CHADDERTON · OLDHAM · LANCS
Telephone: MAIn 6661

FE 257/2

14WW—001 FOR FURTHER DETAILS.

Only 10 seconds for a permanent print!

AVO

Proudly Announce

AVO-BEATTIE-COLEMAN OSCILLOSCOPE CAMERAS

. . A range of instruments covering the entire field of Oscilloscope photography. Polaroid processing backs are standard on most models and these give you finished prints literally within ten seconds. No other equipment and no experience are needed.

Camera Model MII 565, for recording ultra-high-speed nanosecond traces. Has 1 : 1 object/image ratio and an 86mm f/1.2 Navitar lens which is exclusive to A-B-C. When used with the fastest Polaroid film, this remarkable lens gives recording speeds never before obtained with standard equipment.

35mm film is used in Model KD5 for rapid sequence recording or for continuous " streak " recording. There is also a dual-purpose model with a 35mm magazine for high-speed " streak " recording and a Polaroid unit for transient and repetitive phenomena.

Model K5 (illustrated) is surprisingly inexpensive although it has a fast f/1.9 lens, a multi-speed shutter, and is suitable for both repetitive and single shot transient waveforms. An additional " Lensette " converts the K5 for photographing diagrams, circuit breadboards and other laboratory subjects. Interchangeable backs provide for Polaroid roll or flat pack film, or for 4in. x 5in. cut film. Engineers throughout the world specify K5 because of its low cost, ease of use and superior performance.

REMEMBER POPPY DAY

Check these K5 Features:—

★ **Adjustable ratio, 1 : 0.9, 1 : 0.7.**
★ **Multiple exposures, up to 13 on one frame.**
★ **Parallax-free view of C.R.T. during set-up.**
★ **Records written data on film (optional).**
★ **Swing-away, lift-off mounting (optional).**
★ **Lensette attachment for off-'scope pictures.**
★ **10-second developing with Polaroid film.**
★ **Film speeds up to ASA 10,000.**

A-B-C CAMERAS are joint products of Avo Ltd. and Beattie-Coleman Inc. of California. They are fully guaranteed and backed by Avo Service.

Ask AVO for full details or a demonstration.

AVO LTD **AVOCET HOUSE, 92-96 VAUXHALL BRIDGE ROAD, LONDON, S.W.1.** *Victoria 3404 (12 lines)*
IN NORTH AMERICA: BEATTIE-COLEMAN INC., ANAHEIM, CALIFORNIA.

M GROUP

ABC/1

14WW—006 FOR FURTHER DETAILS.

TWO NEW CO-AXIAL LOUDSPEAKERS from CELESTION

STUDIO SERIES

Standard

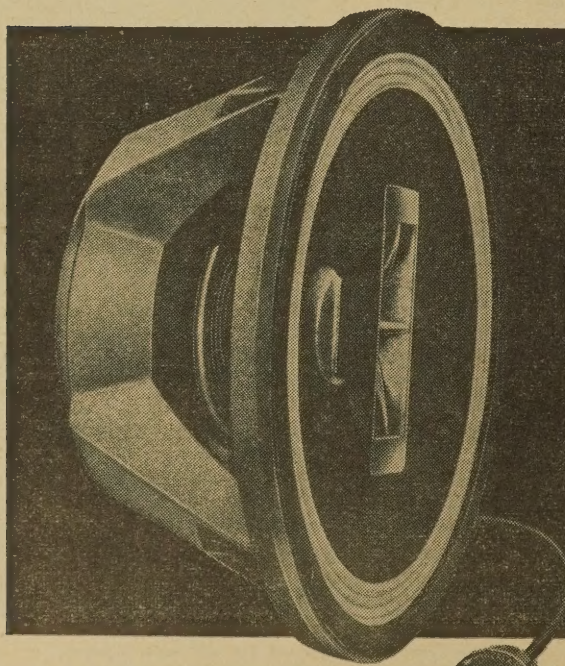
Model CX 1512 **£11/10/-**

12" dia. 15 watts ✳ PLASTAFLEX SURROUND

TWO VOICE COILS ✳ COMPRESSION TREBLE UNIT

✳ PURE ELECTRICAL CROSS-OVER

Overall Frequency Response	30-15000 c/s
Power Handling Capacity	15 watts
Fundamental Resonance	35 c/s
Cross-over frequency	4 Kc/s
Impedance	15/16 ohms
Flux Density	13000 Gauss
Total Flux	88000 Maxwells



STUDIO SERIES

De Luxe

Model CX 2012

12" dia. 20 watts ✳ HI-FLEX 'FREE' SURROUND

TWO VOICE COILS ✳ COMPRESSION HORN LOADED TREBLE UNIT ✳ PURE ELECTRICAL CROSS-OVER

✳ HIGH FREQUENCY LEVEL CONTROL

Overall Frequency Response	30-18000 c/s
Power Handling Capacity	20 watts
Fundamental Resonance	35 c/s
Cross-over frequency	4 Kc/s
Impedance	15/16 ohms
Flux Density	17000 Gauss
Total Flux	180000 Maxwells

£16/10/-

Celestion Studio Series

CELESTION LTD

Thames Ditton, Surrey, Telephone: EMBerbrook 3402/6

14WW—007 FOR FURTHER DETAILS.

Celestion Ltd., Ferry Works, Thames Ditton, Surrey

Please send me details of the 'STUDIO' Series Loudspeakers

Name.....

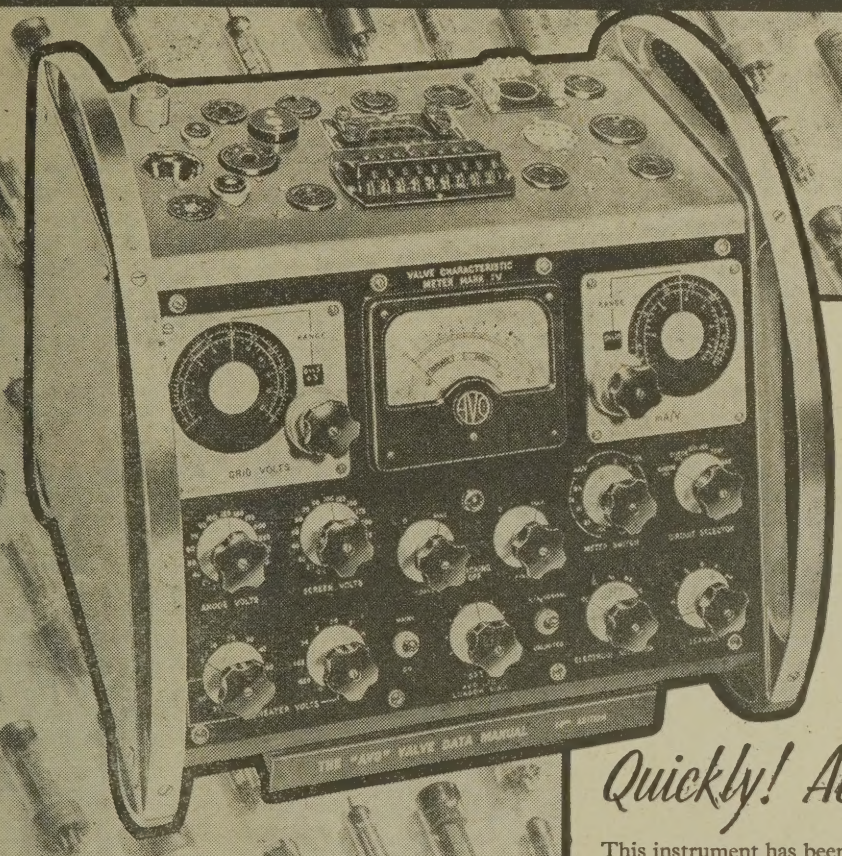
Address.....

.....

A5

AVO

Valve Characteristic Meter *Mk.IV*



Tests over 6,000 types of valves—

Quickly! Accurately!

This instrument has been designed to test any standard receiving or transmitting valve having up to a maximum anode dissipation of 25W. Inter-electrode insulation, anode current, mutual conductance and 'gas' current can be measured, and by making a series of tests, complete families of curves may be plotted. Rectifiers and signal diodes are tested under suitable load conditions. A comprehensive data manual is supplied with the instrument, which operates from 100-120 volts and 200-260 volts 50/60 c/s A.C. mains.

More than 6,000 different kinds of valves can be tested on this instrument without recourse to Manufacturers' data or charts.

Range of Anode Voltage	12.6—400 volts
Range of Screen Voltage	12.6—300 volts
Range of Heater Voltage	0.625—117.5
Heater Current	3A max.
Anode Current	100mA max.
Mutual Conductance ...	0.1—60mA/V max
Negative Grid voltage ...	0–100Vin 9 ranges
'Gas' Current	2μA first indication

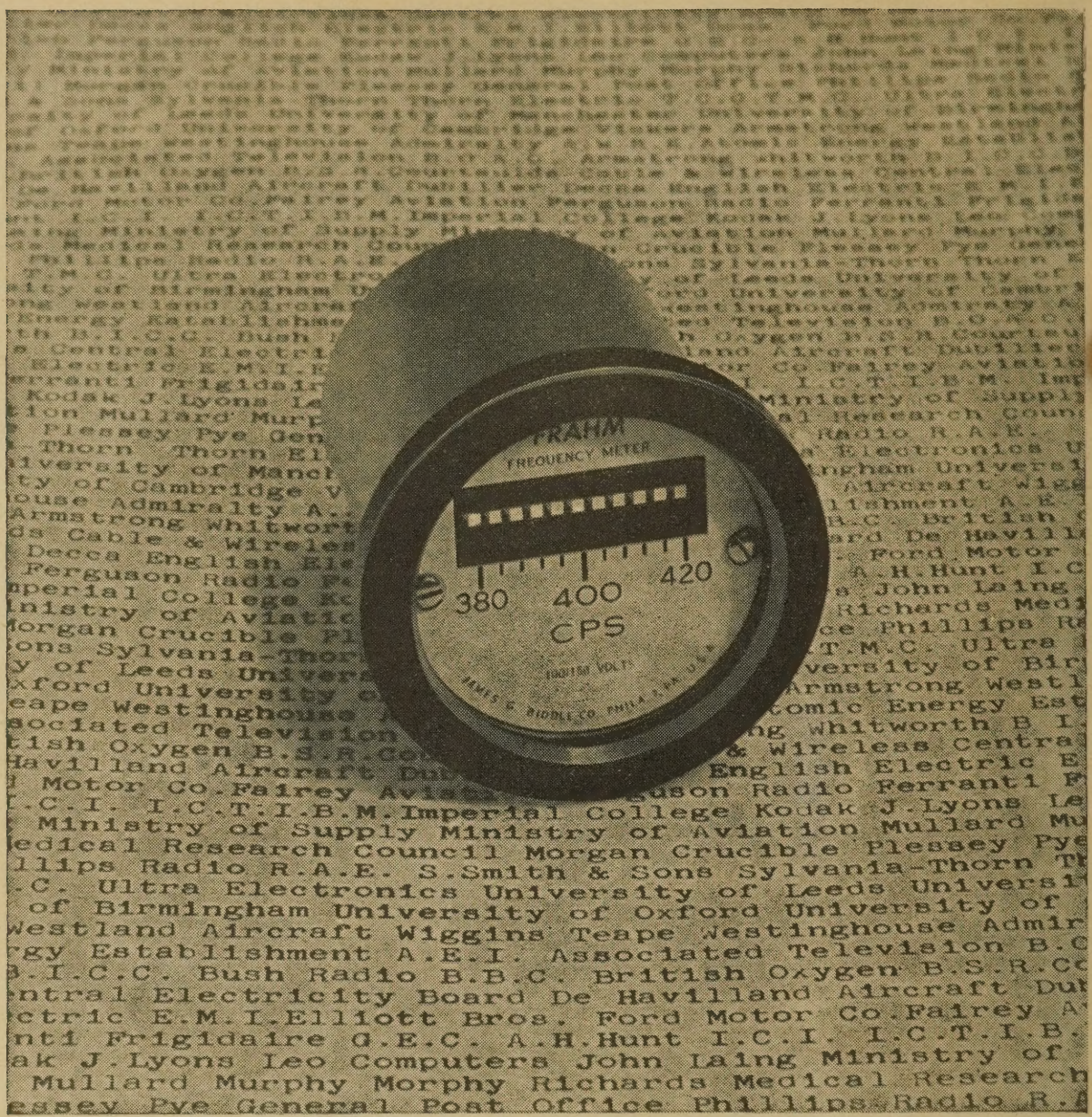
Write for fully illustrated brochure.

The 16th Edition of the AVO VALVE DATA MANUAL is now available. *Price* **£1 : 15 : 0.** *Post & packing free*

AVO LTD AVOCET HOUSE, 92-96 VAUXHALL BRIDGE ROAD, LONDON, S.W.1. *Victoria 3404 (12 lines)* M GROUP

VC8

14WW—008 FOR FURTHER DETAILS.



from ANDERS to industry

meters made to measure

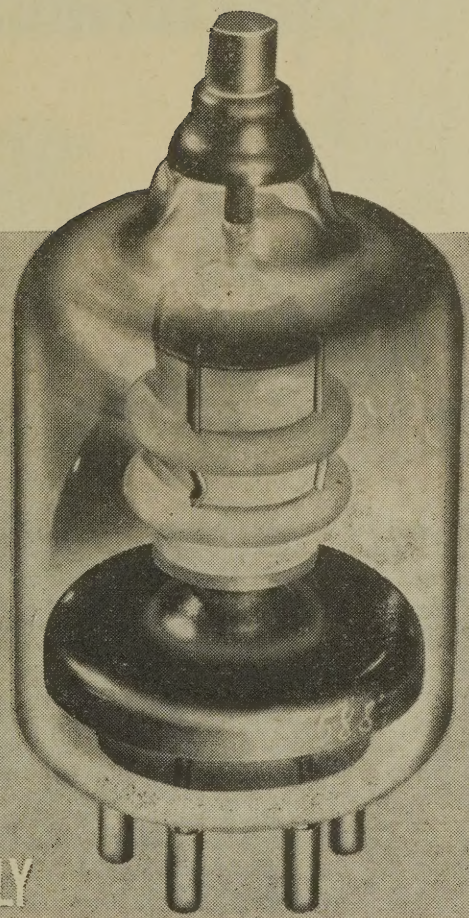
There are many famous users of the Anders service—a service designed to give the speediest possible delivery of even the most unusual meter requirement. The Anders Instrument Centre has unique facilities for supplying non-standard meters of all types, from 1½" miniatures to the largest switchboard meters, specially calibrated and tested. For immediate delivery, Anders carry huge stocks of standard meters of all well-known makes and types. New ranges are constantly being added—Anders are now sole UK agents for the famous Frahm vibrating reed frequency meters and tachometers. 2½" miniature hermetically-sealed instruments to large panel-mounting meters with accuracies of 0.1%.

For full details of the Anders service, please write or 'phone

ANDERS ELECTRONICS LIMITED
103 HAMPSTEAD ROAD, LONDON N.W.1. TELEPHONE: EUSTON 1639
Contractors to GPO and Government Departments. Ministry of Aviation approved.

METERS, ELECTRONIC AND TEST EQUIPMENT TO INDIVIDUAL SPECIFICATIONS
14WW—009 FOR FURTHER DETAILS.

RADIO VALVES



FOR EXPORT ONLY

HALTRON

WORLD WIDE DISTRIBUTION

Although we carry a permanent stock of 4,000,000, with a range of 3,000 types of receiving, special purpose and transmitting tubes as well as transistors, we offer an unparalleled service on 'the difficult types' — on those types which are sometimes hard to come by. Your enquiries for special types to CV, JAN and MIL specifications will have our immediate attention. The name HALTRON stands for a service unsurpassed in the world to-day.

HALL ELECTRIC LIMITED

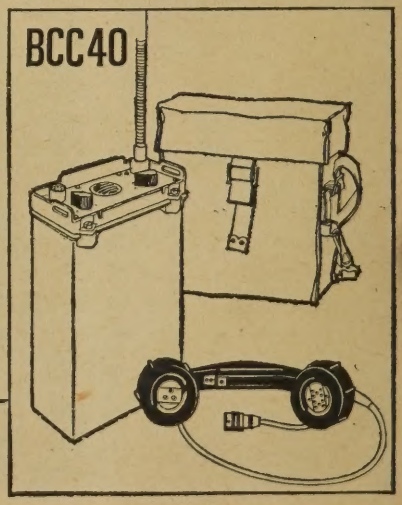
Haltron House, Anglers Lane, London N.W.5 Tel: Gulliver 8531 (10 lines) Telex 2-2573 Cables: "Hallectric London NW5".

14WW—010 FOR FURTHER DETAILS.

high performance

Museum Telephone Exchange and Radio Tower designed by the Chief Architect's Division of the Ministry of Public Building and Works Main Contractors Peter Lind & Co. Ltd.

The higher up the building goes, the more difficult becomes top-level contact with the ground. Wherever problems of communication are involved—such as are encountered in building the new GPO radio tower in London—the BCC 40 portable radiotelephone is the perfect answer.
Fully transistorised, compact and robust, with a proved consistently high performance, the BCC 40 is the natural choice for such undertakings. Designed for the particular needs of armed forces, police and fire services, it is ideal for use in industry where conditions are often equally arduous. The BCC 40 ensures reliable two-way speech communication and provides up to 6 channels in any of the VHF bands. There is also a choice of either P.M. or A.M. operation. The BCC 40 inherits the longstanding reputation of BCC equipments for high performance, reliability and endurance.



BCC BRITISH COMMUNICATIONS CORPORATION LTD.

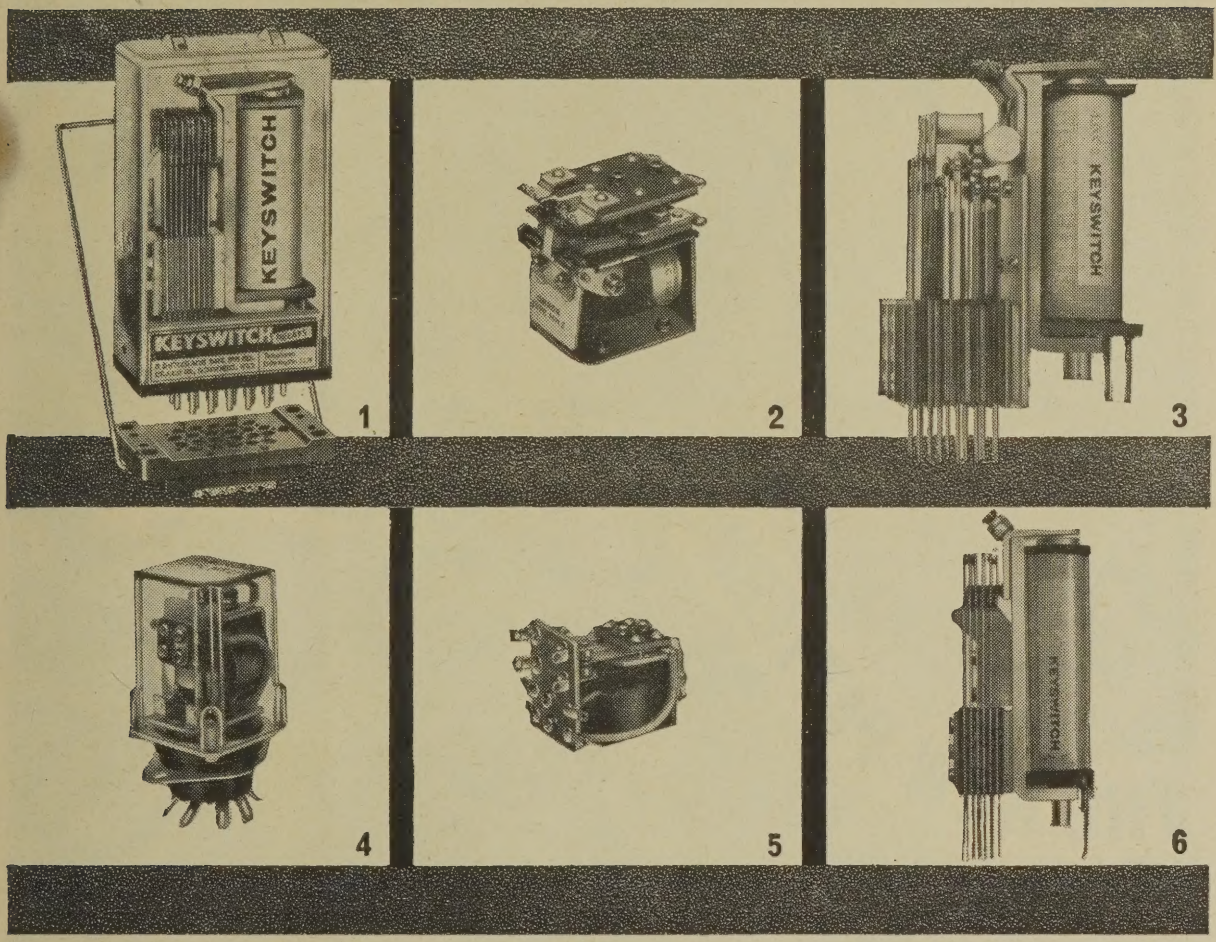
MEMBER OF THE CONTROLS AND COMMUNICATIONS GROUP

EXHIBITION GROUNDS, WEMBLEY, MIDDLESEX
Telephone: Wembley 1212 Telegrams: BEECEECEE WEMBLEY

14WW—011 FOR FURTHER DETAILS.

RELIABLE RELAYS

10 days delivery



KEYSWITCH

Precision relays fully electrically and mechanically tested to exact specification. You can trust them for many purposes, industrial and electronic, and for all kinds of conditions. B.P.O. types by Keyswitch and miniatures by Omron, from milliamps to 30 amps per contact. Operating coils from less than 1v to 200v d.c. and 6v to 440v a.c.

For full details of **KEYSWITCH** and **KEYSWITCH OMRON GOLD** relays contact:

1. KEYSWITCH (P-33) Plug-in 3000 type relay. C.E.G.B. approved. Many variations available.
2. KEYSWITCH OMRON GOLD MM2. Power relay 110v and 230v AC/DC. Up to 4 pole c/o at 15 amps. Switch box mounting.
3. KEYSWITCH K700 type relay. 15-30 amps for high current/high voltage applications.
4. KEYSWITCH OMRON GOLD MK2P. Midget power relay up to 230v AC/DC. Plug-in octal base.
5. KEYSWITCH OMRON GOLD MK2. Midget power relay—smallest of the power series. Up to 3 pole c/o 7.5 amps.
6. KEYSWITCH B.P.O. 600 type minor relay. Small size coupled with higher switching speeds.

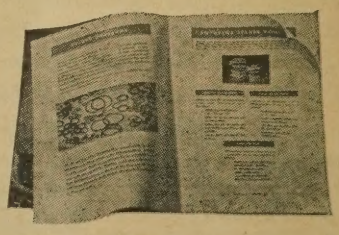
KEYSWITCH RELAYS LTD Cricklewood Lane, London, N.W.2. Tel: GLAdstone 1152

14WW—012 FOR FURTHER DETAILS.

Enthoven Preforms. Solder preforms make for faster, more accurate and therefore *cheaper* soldering. Enthoven are leaders in the design and manufacture of solder preforms, and offer a wide range of alloys, both cored and solid, in the form of rings, washers, discs, shims, strips and ribbon.

Enthoven are always ready to discuss any industrial soldering problem, and, if necessary, to design special preforms in the light of your requirements and of their long experience of precision soldering techniques.

This free booklet describes the complete range of Enthoven Solder Products . . . preforms among them. Ask for a copy.

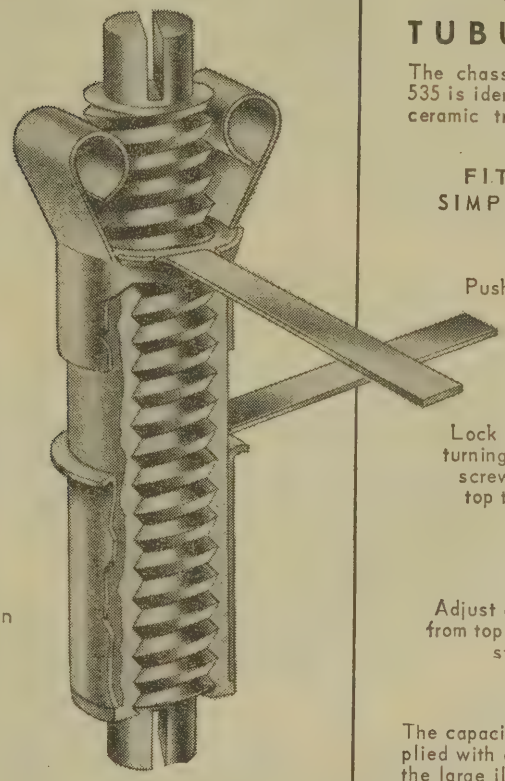


ENTHOVEN SOLDERS LIMITED

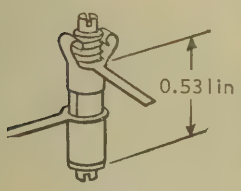
Sales Office & Works: Upper Ordnance Wharf, Rotherhithe Street, London, S.E.16. BER 2014
Head Office: Dominion Buildings, South Place, London, E.C.2. MONarch 0391

14WW—013 FOR FURTHER DETAILS.

REAL MINIATURIZATION...
PLUS LOW LOSS FOR UHF...



STYLE 535
TUBULAR TRIMMER
(PATENTED)
ILLUSTRATED
ACTUAL SIZE

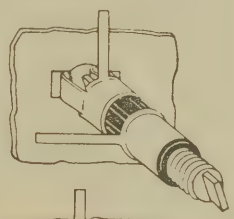


ERIE STYLE 535 TUBULAR TRIMMER

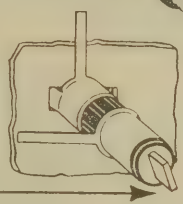
The chassis punch-out required for the Style 535 is identical to that required for the tubular ceramic trimmers that are in general usage.

FIT THIS SIMPLE WAY

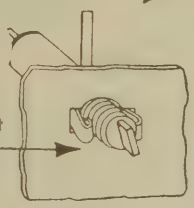
1 Push in hole



2 Lock in hole by turning adjusting screw through top terminal



3 Adjust capacitance from top at final test station



The capacitance adjusting plunger can be supplied with either the screwdriver slot shown in the large illustration, or with a milled flat end illustrated above.

The simplicity of design of the Style 535 trimmer results in very low inductance and uniform, linear, noiseless adjustment: the ribbon-type leads help to minimise inductance in UHF circuits. When mounted, the high-temperature polystyrene body extends only 0.531in from the underside of the chassis and is only 0.218in in diameter.

The Style 535 Tubular Trimmer combines the desirable features of small size, easy mounting, stable performance and economical price. Capacitance range is from 0.7 to 3pF and working voltage is 500 d.c. Variations in terminal orientation and hardware can be provided on request, according to demand.

Write for 535 literature

ERIE ELECTRONIC COMPONENTS

*Registered Trade Mark

ERIE RESISTOR LIMITED GREAT YARMOUTH NORFOLK Telephone 4911 Telex 1720

14WW—014 FOR FURTHER DETAILS.

The shapes of sound

PRECISION AT EVERY POINT

Quite apart from its exceptional performance, the Goldring-Lenco GL 70 is an eminently satisfying unit just to look at. It is Swiss precision engineered throughout and incorporates the superb L.70 Transcription Arm, which is a high-fidelity masterpiece in its own right. The turntable is die-cast from non-magnetic material and weighs 8 lbs. Continuously variable speed adjustment from above 80 r.p.m. to below 30 r.p.m. and from 15-18 r.p.m., with positive click-in positions for standard speeds. A pick-up lowering device is incorporated to enable the arm to be gently lowered onto any part of the record, or raised, by turning the play switch to 'on' or 'off'. The GL 70 is, in fact, an instrument capable of meeting the highest demands of the discriminating enthusiast.

GOLDRING-LENCO

GL 70

£23 12s 6d
(+P.T. £3 16s 10d)

GL 70/P
(Mounted on box-type base)

£26 12s 6d
(+P.T. £4 6s 7d)

GOLDRING MANUFACTURING CO. (G.B.) LIMITED, 486-488 HIGH ROAD, LEYTONSTONE, LONDON, E.11

TELEPHONE : LEYTONSTONE 8343

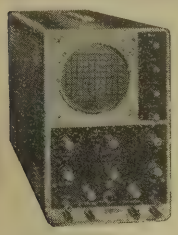
14WW—015 FOR FURTHER DETAILS.

The Quality Kit-sets

Heathkit DAYSTROM

Anyone can build

INSTRUMENTS FOR LABORATORY, TEST, SERVICE AND HOME WORKSHOP



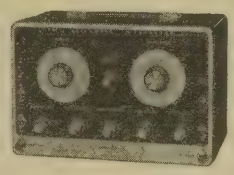
5in. Flat-face GENERAL PURPOSE OSCILLOSCOPE Model 10-12U

An outstanding new 'scope

"Y" sensitivity 10mV. r.m.s. per cm. at 1 kc/s. bandwidth 3 c/s.-4.5 Mc/s. Frequency compensated input attenuator X1, X10, X100. T/B. 10 c/s.-500 kc/s. in 5 steps. Two extra switch selected pre-set sweep frequencies in T/B. range. T/B. output approx. 10 v. peak to peak. Built-in 1V calibrator. Facility for "Z" axis modulation. Electronically stabilised power supply. Power req. 200-250 v. A.C., 40-60 c/s., 80 watts. Fused. Front panel silver and charcoal grey. Cabinet, charcoal grey, size 8⅜ x 14 x 17in. deep. Net weight 23lb. 56-page construction and operation manual.

Kit ..... **£32.12.6** Assembled **£41.10.0**

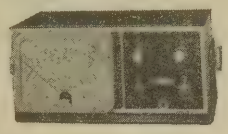
TV ALIGNMENT GENERATOR



Model HFW-1 Designed to offer the maximum in performance, flexibility and utility at the lowest possible cost. Frequency coverage 3.6 Mc/s. to 220 Mc/s. on fundamentals. Unique non-mechanical sweep oscillator system. High level output on all ranges. Sweep deviations up to 42 Mc/s. Built-in fixed and variable marker generators. (5 Mc/s. crystal supplied.) Power requirements: 110/200-250 v. A.C., 50 watts. Size 13 x 8½ x 7in.

Kit ..... **£30.15.0.** Assembled **£44.10.0**

De Luxe 6in. VALVE VOLTMETER Model IM-13U



Modern styling. Extra features. The ideal VVM for the Electronic Engineer. 6in. Ernest Turner 200μA. meter with multi-coloured scales. Unique gimbal bracket allows bench, shelf or wall mounting. Measures A.C. (r.m.s.), D.C. volts 0-1.5, 5, 15, 50, 500, 1,500. Resistance range 0.1 to 1,000MΩ with int. battery. Vernier-action zero and ohms adjustment. Roller-tinned printed circuit. High input resistance (11MΩ). Comprehensive assembly and operation manual. Size 5 x 12¼ x 4¾in. Complete with test prod and leads.

Kit ..... **£18.18.0** Assembled **£26.18.0**

H.T. and R.F. Probes available as optional extras.

R.F. SIGNAL GENERATOR

Model RF-1U Provides extended frequency coverage in six bands from 100 kc/s. to 100 Mc/s. on fundamentals and up to 200 Mc/s. on calibrated harmonics. Six large dial scales allow precise frequency settings. Modulated or unmodulated R.F. output of at least 100 millivolts. 400 cycle audio signal with 5 volt output. Pre-aligned coil and band switch assembly for ease of construction.

Kit ..... **£13.8.0** Assembled **£19.18.0**

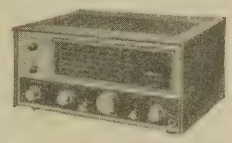
OUTSTANDING EQUIPMENT FOR THE "AMATEUR" & SHORT WAVE LISTENER

GENERAL COVERAGE RECEIVER Model RG-1

An inexpensive communications type receiver designed for the discriminating short wave listener. Frequency coverage 32 Mc/s. to 1.7 Mc/s. in 5 ranges, plus the MW band of 1,500 kc/s. to 600 kc/s. Modern design techniques and special frame grid valves secure a high standard of performance. Image rejection and signal-to-noise ratio are exceptionally good. Each of the six bands is separately calibrated on a large slide-rule dial. The Coil Pack and IFT's are pre-assembled and aligned ready for use. Special features include: Half-lattice crystal filter; Variable noise limiter; Voltage stabilised oscillators.

Kit ..... **£39.16.0** Assembled **£53.0.0**

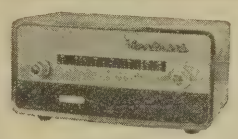
AMATEUR BANDS RECEIVER Model RA-1



This receiver is designed as an ideal economically priced fixed station, portable or mobile receiver covering the amateur bands from 160-10 m., each band separately calibrated on a large illuminated slide-rule dial. Approx. 5in. bandspread on each band. **Features:** Signal strength (tuning) "S" meter, front panel dial calibration control, provision for a 100 kc/s. calibrator, tuned R.F. amplifier stage, half-lattice filter, adjustable noise limiter. Excellent electrical and mechanical stability. **Frequency coverage:** 160, 80, 40, 20, 15, 10 metre bands. I.F. 1620 kc/s. Sensitivity: 2μV for 10 dB S/N, image rej. 40 dB. Power requirements: 110-240 v. A.C. 40-60 c/s. (Provision for external P.S. for mobile use.) Size 13¾in. wide x 6¼in. high x 10⅝in. deep. Kit **£39.6.6** Assembled **£52.10.0**

A WORLD OF ENTERTAINMENT FOR THE FAMILY

A WELL DESIGNED F.M. TUNER Model FM-4U



Tuning range 88-108 Mc/s. Flywheel tuning. Attractive Plastic Front Panel in two-tone grey with golden trim surround and motif. Thermometer type visual tuning indicator. Pre-aligned. I.F. transformers. Three I.F. stages, Wide-band low distortion Ratio Detector. R.F. Unit, wired, tested and pre-aligned. Printed circuit for I.F. Amplifiers and Ratio Detector. Built-in power supply, Output sockets for stereophonic adaptor (for stereo transmission when available).

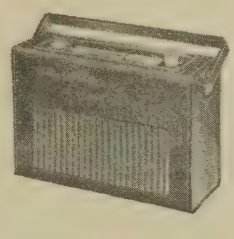
TUNER UNIT Model FMT-4U with 10.7 Mc/s. I.F. output. **£2/15/-** (inc. P.T.).

I.F. AMPLIFIER and power supply Model FMA-4U complete with case and valves, **£13/3/-**. Sold separately.

Assembly can be arranged on your behalf.

Kit Total **£15.18.0**

"OXFORD" LUXURY TRANSISTOR PORTABLE Model UXR-2



This superb transistor radio is the ideal domestic or personal portable Medium and Long Wave receiver. Solid leather case and handle. Easy-to-read tuning scale. Extra large loudspeaker. Push buttons L, MW and tone. 10 semi-conductors (7 transistors plus 3 diodes). Sockets for personal earphone, tape recorder, car aerial.

Assembly can be arranged on your behalf.

Kit **£14.18.0**

SEE OTHER PAGES FOR MANY MORE MODELS IN THE HEATHKIT RANGE

DAYSTROM LTD.

DEPT. W.W.11, GLOUCESTER, ENGLAND

MANUFACTURERS OF KIT-SETS FOR EVERY INTEREST—HOME, SERVICE, WORKSHOP, LABORATORY, ETC.

14WW—016 FOR FURTHER DETAILS

So easy to build **Heathkit** DAYSTROM *So easy to use*

AMERICAN HEATHKIT SINGLE SIDE-BAND EQUIPMENT

(AS STOCKS IN U.K. ARE LIMITED, ORDER AS EARLY AS POSSIBLE TO AVOID DISAPPOINTMENT)

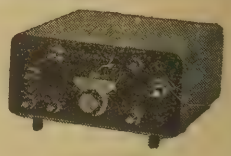
SB-400E

80-10M RECEIVER Model SB-300E

This de luxe receiver offers unsurpassed value to the radio amateur. Of advanced design, employing up-to-date construction techniques, its specification ensures unparalleled performance. Size 14⅞in. x 6⅝in. x 13⅜in. Full details on request.

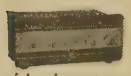
Kit (less speaker) **£133 14 0**

A fitting companion to this receiver is the Model



SB-300E

6 W STEREO AMPLIFIER KIT Model S-33



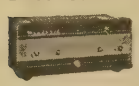
A versatile high-quality self-contained STEREO/MONAURAL Amplifier with adequate output for a living room. Can be used to convert a favourite (monaural) radiogram into a stereo-radiogram. 3 watts per channel: 0.3% distortion at 2.5 w/chnnl.; 20 dB N.F.B., inputs for Radio (or Tape) and Gram., Stereo or Monaural; Ganged controls. Sensitivity 200 mV.

Kit **£13.7.6** Assembled **£18.18.0**

6 W HI-FI STEREO AMPLIFIER KIT Model S-33H

An inexpensive stereo-mono amplifier with the high sensitivity necessary for lightweight miniature ceramic pick-ups (e.g., Decca Deram). De luxe version of the S-33 with attractive two-tone grey Perspex panel. Kit **£15.17.6** Assembled **£21.7.6**

5 W HI-FI MONO AMPLIFIER KIT Model MA-5



A low-priced general purpose Hi-Fidelity amplifier based on the popular S33 for those who do not require a stereophonic system. Separate bass and treble controls. Gram and Radio inputs. Suitable for most crystal pick-ups. A printed circuit simplifies construction.

Kit **£10.19.6** Assembled **£15.10.0**

HI-FI SINGLE CHANNEL AMPLIFIER KIT Model MA-12

A compact high fidelity power amplifier (including auxiliary power supply). 12 watts output. Wide frequency range and low distortion. A variable sensitivity control is fitted enabling it to be used with an existing amplifier in a stereophonic system. Other applications include sound reinforcement systems, transmitter modulators, for use with tape recorders, also as a general purpose laboratory amplifier.

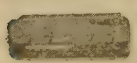
Kit **£11.18.0** Assembled **£15.18.0**

STEREO-HEAD BOOSTER KIT Model USP-1

Hi-Fi Stereo Pre-amplifier for low-output Hi-Fi P.U.s input 2 mV. to 20 mV. Output adjustable from 20 mV. to 2 V. 40-20,000 c/s. Also suitable as low-noise R.C.-coupled amplifier.

Kit **£7.7.6** Assembled **£10.9.6.**

STEREO CONTROL UNIT KIT Model USC-1



Incorporates all worthwhile features for high fidelity stereo and mono. Push-button selection, accurately matched ganged controls to ± 1 dB. Negative feedback rumble and variable low-pass filters. Printed circuit boards. Accepts inputs from most tape-heads and any stereo or mono pick-up.

Kit **£19.10.0** Assembled **£26.10.0**

SB-400E TRANSMITTER Kit £165.4.0

3in. MONITOR, SCOPE Model HO-10E

A must for the SSB enthusiast. Gives at-a-glance visual indication of your transmitted signal and incoming signal displaying envelope patterns. Built-in two-tone generator ensures a clear output signal. Power req. 115-230 v. A.C.

Kit £34.10.0.

MANY OTHER MODELS. SEND FOR DETAILS.

PUBLIC ADDRESS AMPLIFIER KIT Model PA-1

This is a multi-purpose, high output, compact unit suitable for vocal and instrumental groups, guitars, electronic organs, etc. 4 inputs for guitars, mics., record players. Has many features found only in expensive equipment, i.e., 50 watt R.M.S. output, two heavy duty speakers. "Magic Eye" vol. indicator, variable tremolo, elegant cabinet.

Kit **£54.15.0** Assembled **£74** legs 17/6 extra.

"MALVERN" HI-FI EQUIPMENT CABINET KIT

AN ATTRACTIVE CABINET in modern style designed to house all your Hi-Fi equipment (including tape deck and full-sized transcription record player). The cabinet parts are veneered and pre-drilled, with edging in Panoplex plastic strip for ease of finishing. Complete with everything you need for assembly, including screws, hinges and even a padsaw! Left "in the white" for finishing to choice. Size 39⅛ x 32 x 21⅛in.

Kit **£18.1.0** Assembled **£23.6.0**

"GLOUCESTER" HI-FI CABINET KIT

OPEN

Will accommodate: Tape Deck and/or Record Player. F.M. Tuner and Stereo Amplifier. For those with limited floor space a speaker system can be housed at one end. For this purpose a loudspeaker kit comprising one 4in. plus 8in. speaker systems, balance unit, speaker grille, cutting template, padsaw and mounting details is also available. Neutral hardwoods have been carefully selected so that the finished product can be stained and polished to individual choice. There is storage space for records, etc., also for power amplifiers. Dimensions: length 46½in., height 30in., depth 21in.

Mk. I for Tape Deck or Record Player

Kit **£17 3 6** Assembled **£22 8 6**

Mk. II for both T/D and R/P

Kit **£18 10 0** Assembled **£23 15 0**

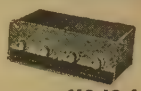
● INTERNATIONAL MAIL ORDER SCHEME ●

Covering the American Heathkit range of 250 models

Direct from U.S.A. to your U.K. address. Illustrated American catalogue and full details can be obtained from us for 1/- post paid.

● Deferred Terms available on all orders above £10 ●

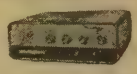
MONO CONTROL UNIT KIT Model UMC-1



Ideal for use with MA-12 or similar amplifier. Output 0.25 v. *Send for full details.*

Kit **£8.12.6** Assembled **£13.12.6**

HI-FI STEREO AMPLIFIER KIT Model S-99



Gives 18 w. output (9 per channel with 0.2 per cent. distortion at 9 w. per channel). It has ganged controls. STEREO/MONAURAL gram., radio and tape recorder inputs and push-button selection as well as many other first-class features well above its price range. In grey metal cabinet with a golden surround and Perspex panel. Also ultra-linear push-pull output. Printed circuit construction.

Kit **£27.19.6** Assembled **£37.19.6**

HI-FI SPEAKER SYSTEM KIT Model SSU-1

Ducted-port bass reflex cabinet "in the white." Frequency response is 40-16,000 c/s. Power rating 25 watts. Matched speaker units 8in. high flux (12,000 lines) with hyperbolic cone and 4in. wide angle dispersion type for higher frequencies.

Kit (with legs) **£11.12.0** (Less legs) **£10.17.6**

"COTSWOLD" SPEAKER SYSTEM KIT

This acoustically designed enclosure measures 26 x 23 x 14½in., and houses a special 12in. bass speaker with 2in. speech coil, elliptical middle speaker together with a pressure unit to cover the full frequency range of 30-2,000 c/s. Its polar distribution makes it ideal for really Hi-Fi Stereo. Delivered complete, with speakers, cross-over unit, level control, grille cloth, etc. Left "in the white" for finish to personal taste, all parts are pre-cut and drilled for ease of assembly.

Kit **£23.4.0** Assembled **£30.15.0**

"COTSWOLD M.F.S." SPEAKER SYSTEM KIT

This model, based on the standard Cotswold, measures only 36in. high, 16½in. wide by 14in. deep. Particularly recommended to those who require the best results in small rooms.

Kit **£23.4.0** Assembled **£30.15.0**

TELEPHONE AMPLIFIER KIT

Model TTA-1 for home, office or shop.

Kit **£7.9.6.** Assembled **£11.15.0**

DAYSTROM LTD.

DEPT. W.W.11, GLOUCESTER, ENGLAND

A SUBSIDIARY OF THE WESTON INSTRUMENTS GROUP, MANUFACTURERS OF

14WW—017 FOR FURTHER DETAILS.

Technically **Heathkit** DAYSTROM excellent

MULTIMETER KIT Model MM-1U

Provides wide voltage, current, resistance and dB ranges to cover hundreds of applications. Sensitivity 20,000 ohms/volt D.C. and 5,000 ohms/volt A.C. Ranges: 0-1.5 v. to 1,500 v. A.C. and D.C.; 0-150μA. to 15 A. D.C. Measures resistance from 0.2Ω to 20MΩ. 4½ in. 50μA meter. A polarity reversing switch eliminates transferring test leads when alternately measuring + and — voltages. Uses standard commercial batteries.

Kit **£12.18.0** Assembled **£18.11.6**

ELECTRONIC SWITCH KIT Model (Oscilloscope Trace Doubler) S-3U

This device will extend the use of your single-beam oscilloscope and at a nominal cost, will give you the advantages of a double (or other multiple) beam 'scope, while retaining all the advantages of your present single-beam instrument.

Hitherto an electronic switch of this nature, permitting the simultaneous observation of two signals on the screen of a single-beam C.R.T. oscilloscope, has cost nearly as much as the 'scope itself.

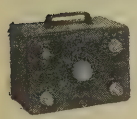
Kit **£12.18.0** Assembled **£18.10.0**

DECADE RESISTANCE BOX KIT

Model DR-1U. Range 1-99,999Ω in 1Ω steps. Ceramic switches throughout. Current rating from 500 mA. to 5 mA. according to decades in circuit. Polished wooden cabinet supplied complete.

Kit **£10.8.0** Assembled **£14.8.0**

RESISTANCE-CAPACITANCE BRIDGE KIT Model C-3U



Measures capacitance 10pf. to 1,000μF. Power factor and resistance 100Ω to 5M ohms. Test voltages 5-450 v. Safety switch provided.

Kit **£10.10.0** Assembled **£16**

AUDIO SIGNAL GENERATOR KIT Model AG-9U

10 c/s. to 100 kc/s., switch selected. Distortion less than 0.1%. 10 v. sine wave output metered in volts and dB's.

Kit **£22.10.0** Assembled **£30.10.0**

AUDIO VALVE MILLIVOLTMETER KIT Model AV-3U

A very sensitive meter with high stability. 1 mV. to 300 v. A.C. The frequency response is virtually flat up to 100 v. f.s.d. within ±1 dB from 10 c/s. to 400 kc/s. 4½in. 200μA. moving coil meter.

Kit **£16.10.0** Assembled **£22.18.0**

AUDIO WATTMETER KIT Model AW-1U

This popular meter is used in many recording studios and broadcasting stations as a monitor as well as for servicing purposes. Dissipation rating up to 25 w. continuous. 50 w. intermittent.

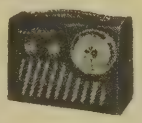
Kit **£17.5.0** Assembled **£23.18.0**

A.M./F.M. TUNER KIT

Tuning range 88-108 Mc/s. (FM) 16-50, 200-550, 900-2,000 m. Flywheel tuning. Attractive Perspex front panel in two-tone grey with golden trim. Thermometer type tuning indicator, pre-aligned I.F. transformers. Switched wide and narrow A.M. bandwidths.

TUNING HEART Model AFM-T1 £4.13.6 (inc. P.T.) **I.F. AMPLIFIER and Power Unit Model AFM-A1.** Complete with metal cabinet and valves **£21.16.6** Sold separately. Kit Total **£26.10.0**

TRANSISTOR PORTABLE RADIO KIT Model UXR-1



Presented in elegant real hide case with tasteful gold relief. Can be assembled in 4 to 6 hours and you have a set in the top flight of transistor portables. Pre-aligned I.F. transformers, printed circuit and a 7in. x 4in. high flux speaker.

Kit **£12.11.0**

4-wave TRANSISTORISED PORTABLE RADIO KIT Model RSW-1

Using 7 latest type transistors and three diodes this highly sensitive set is specially designed for Short and Medium wavebands (200-550, 90-200, 20-40 and 11-16 m.). In solid leather case fitted with retractable whip aerial.

Kit **£19.17.6**

TRANSISTOR RADIO KIT Model UJR-1

Dual-wave headphone receiver for use with external aerial and earth. An ideal introduction to radio.

Kit **£2.7.6**

Additional Amplifier Stage UJR-1S, **16/6.**

ELECTRONIC WORKSHOP KIT Model EW-1. Makes over 20 experiments.

Kit **£7.13.6**

TAPE DECKS are available as "packaged deals" with other equipment. Details on request.

Money-back Guarantee

Daystrom Limited unconditionally guarantee that each Heathkit model assembled in accordance with our easy-to-understand instruction manual must meet our published specifications for performance or the purchase price will be cheerfully refunded.

4½in. VALVE VOLTMETER KIT Model V-7A

The world's most popular valve voltmeter, with printed circuit and 1 per cent. precision resistors to ensure consistent laboratory performance. It has 7 voltage ranges measuring respectively D.C. volts to 1,500 and A.C. to 1,500 r.m.s. and 4,000 peak to peak. Resistance measurements from 0.1 ohm to 1,000 megohms with internal battery. D.C. input resistance is 11 megohms and dB measurement has a centre-zero scale. Complete with test prod, leads and standardising battery. Power requirements. 200-250 v. 40-60 c/s A.C., 10 watts.

Kit **£13.18.6** Assembled **£19.18.6**

HIGH VOLTAGE PROBE KIT Model HV-336

Extends measurement up to 30,000 v. D.C. with negligible circuit loading. A special High Stability 1,090 megohm resistor gives a multiplication factor of 100X when used with a valve voltmeter of 11 megohms input resistance such as the V-7A.

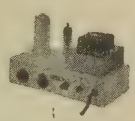
Kit **£2.19.6**

R.F. PROBE KIT Model 309-CU

This complete probe kit will extend the frequency range of the V-7A Valve Voltmeter to 100 Mc/s. and will enable useful voltage indication to be obtained up to 300 Mc/s.

Kit **£1.13.6** Assembled **£2.2.0**

POWER SUPPLY UNIT KIT Model MGP-1



Compact, general purpose unit suitable for F.M. Tuners, Tape Recording Amplifiers and general laboratory use. Input 100/120 v., 200/250 v., 40-60 c/s. Output 6.3 v., 2.5 A. A.C.; 200, 250, 270 v., 120 mA. max. D.C.

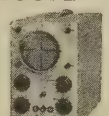
Kit **£5.2.6** Assembled **£6.12.6**

DECADE CAPACITOR KIT Model DC-1

Capacity values 100μμF to 0.111μF. in 100μμF. steps Precision silver-mica capacitors and minimum loss ceramic wafer switches ensure high accuracy.

Kit **£7.5.0** Assembled **£10.8.0**

2¾in. SERVICE OSCILLOSCOPE KIT Model OS-1



Light, compact, portable for service engineers. Printed circuit board for easy construction. Time base 15 c/s. to 150 kc/s. in four ranges and 50 c/s. sine wave sweep. Flyback suppression on all ranges. Internal, external and 50 c/s sync. Size 5 x 8 x 14½in. long. Weight 10½ lb.

Kit **£22.18.0** Assembled **£30.8.0**

CAPACITANCE METER KIT Model CM-1U

This Direct-Reading Capacitance Meter is a very low priced, time-saving instrument which is so useful that it should be part of the general equipment of every electronic laboratory and production line. Easily built in a few hours. 0-100μμF., 0-1,000μμF., 0-0.01μF., 0-0.1μF. The meter has 4½in. scale and can be used by an unskilled operator after a few minutes' instruction.

Kit **£15.15.0** Assembled **£21.14.0**

• *Deferred Terms available on all orders above £10* •

DAYSTROM LTD.

DEPT. W.W.11. GLOUCESTER, ENGLAND

THE WORLD'S LARGEST-SELLING ELECTRONIC KIT-SETS

14WW—018 FOR FURTHER DETAILS.

thoroughly **Heathkit** DAYSTROM dependable

AMATEUR TRANSMITTER KIT
Model DX-40U

Covers all amateur bands from 80 to 10 metres, crystal controlled. Power input 75 watts C.W. 60 watts peak controlled carrier phone. Output 40 watts to aerial. Provision for VFO. Filters minimise T.V. interference. Modulator and power supplies are built-in. Single knob band switching is combined with a pi-network output circuit for complete operating convenience. A high-grade moving-coil meter indicates the final grid or anode current. Provision is made for the use of 3 crystals with access through a trap-door in the back of the cabinet. A 4-position switch selects the appropriate crystal or a jack for external VFO which can be used instead of the crystal(s).

Kit ... **£33.19.0** Assembled ... **£45.8.0**

SINGLE SIDEBAND ADAPTER KIT
Model SB-10U

May be used with most A.M. transmitters with certain provisions. Allows full use of existing equipment for SSB facilities. Band coverage: 80, 40, 20, 15, 10 m. Unwanted sideband suppression: better than 30 dB. Carrier suppression: better than 40 dB. Power requirements: 300 v. D.C. 85 mA. (average). 30 mA (standby), 140 mA (transmit). 6.3 v. A.C., 3.5 A. Meter: 2½in. Scale edge reading, 200μA movement, indicates carrier null and relative power output. Cabinet 11in. high x 8in. wide x 14¾in. deep.

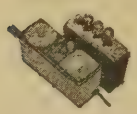
Kit ... **£39.5.0** Assembled ... **£54.18.0**

AUDIO SINE-SQUARE WAVE GENERATOR KIT. Model AO-1U

Covers 20 c/s. to 150 kc/s. in four ranges with choice of sine or square waves. The latter up to 10 kc/s. Output 10 v. max. and distortion less than 1%. Ideal for audio testing. Size 9½ x 6½ x 5in.

Kit ... **£14.15.0** Assembled ... **£2.15.0**

GRID-DIP METER KIT Model GD-1U



Functions as oscillator or absorption wave meter. With plug-in coils for continuous frequency coverage from 1.8Mc/s. to 230 Mc/s.

Kit ... **£10.19.6** Assembled ... **£13.19.6**

Additional Plug-in Coils Model 341-U extend coverage down to 350 kc/s. With dial correlation curves, 17/6.

TRANSISTOR INTERCOM KITS
Models XI-1U and XIR-1U

Ideal for home or business use. Up to five remote stations can be operated with each Master. The Master unit can call any one, any combination, or all five Remote stations and any Remote station can call the Master. A private call to any Remote station cannot be interrupted or overheard by any other while a conversation is in progress. Any Remote station can talk to any one or all others provided the Master is manned. These kits have been designed for easy construction and high performance. The mahogany veneered wooden cabinets are supplied completely assembled and finished. The Master unit has a 4-transistor amplifier and is operated by an internal 9 v. battery as are the Remote units. Batteries are not included with the Kits.

Model XI-1U (Master)

Kit ... **£10.19 6** Assembled ... **£16.19.6**

Model XIR-1U (Remote)

Kit ... **£4.7.6** Assembled ... **£5.16.0**

"MOHICAN" GENERAL COVERAGE RECEIVER KIT
Model GC-1U

This fully transistorised receiver which includes 4 piezo - electric transfilters, is in the forefront of receiver design. It is an excellent portable or fixed station receiver. The R.F. "front-end" is supplied as a pre-assembled and pre-aligned unit. Its many features include a 10-transistor circuit, printed circuit board, telescopic whip antenna, tuning meter, and a large slide-rule dial giving a total length of approximately 70 inches.

Housed in a steel cabinet and powered by two 6 volt dry batteries (not supplied), mounted internally, it gives frequency coverage from 580 kc/s. to 30 Mc/s. in five bands; thus enabling world-wide reception.

Electrical bandspread covers the amateur bands from 80 to 10 metres—each band having a scale length of approximately 8 inches. B.F.O. tuning and Zener diode stabiliser. Size 6⅞ x 12in. x 10in.

Please write for specification leaflet.

Kit **£37.17.6**. Asmbld. **£45.17.6**

STABILISED POWER PACK
Models MSP-1M and MSP-1W

Specially recommended for industrial and laboratory use, meeting the need for a reliable and versatile stabilised power pack capable of a very high performance. Input 200-250 v. 40-60 c/s., A.C., fully fused. Outputs: H.T. 200-410 v. D.C. at 20-225 mA in 3 switched ranges. Unstabilised A.C., 6.3 v. at 4.5 A. centre-tapped. Two 3in. "easy-to-read" meters for reading voltage and current simultaneously. Separate L.T. and H.T. supply transformers. All output circuits are isolated. Size 13in. x 8½in. x 9½in.

MSP-1M (with meters)

Kit **£36.12.6** Asmbld. **£43.12.6**

MSP-1W (less meter)

Kit **£29.17.6** Asmbld. **£36.17.6**

BALUN COIL UNIT KIT

Model B-1U. Will match unbalanced co-axial lines to balanced lines of either 75 or 300Ω impedance. Frequency range 10-80 m., input up to 200 watts.

Kit **£4.15.6** Asmbld. **£5.8.6**

TAPE AMPLIFIER KITS

Model TA-1M

Kit **£19.18.0** Assd. **£28.18.0**

Model TA-1S

Kit **£25.10.0** Assd. **£35.18.0**

Model TA-1C

Kit **£6.15.0.**

All prices include free delivery in the U.K.

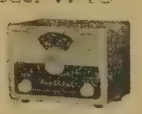
● **Deferred Terms** ● **available on all orders above £10.**

AMATEUR TRANSMITTER KIT
Model DX-100U
The World's most popular Amateur TX Kit

- Completely self-contained compact Amateur Transmitter, 150 w. D.C. input.
- Built-in highly stable VFO and all Power Supplies.
- TVI: Careful design has reduced TVI to a minimum by use of effectively screened frequency generating stages and pi-tuned circuits at the input and output of the PA stage and by 11 chokes and pi-network filters to all outlets from the cabinet. No fewer than 35 disc-ceramic by-pass capacitors help to achieve the exceptional stability and high-performance for which this Transmitter is noted.
- The KT88 high-level anode and screen modulator stage gives over 100 watts of audio from less than 1.5 mV. input.
- Adjustable drive and clamp control ensures that valves are only driven sufficiently to maintain the required output.
- Keying on CW is via the VFO and buffer amplifier cathodes; the other RF valves are biased beyond cut-off. When zero-beating the TX with incoming signals, the exciter stages only may be run without the final amplifier being switched on.
- Provision has been made for remote control operation.
- VFO slow-motion drive is very smooth and backlash free. ● VFO or Crystal control.
- Covers all Amateur bands up to 30 Mc/s. 'phone or CW.

Kit ... **£79.10.0** Assembled...**£104.15.0**

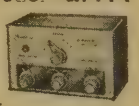
VARIABLE FREQUENCY OSCILLATOR KIT. Model VF-1U



Specially designed to meet the demand for the maximum possible flexibility from an amateur Transmitter which would otherwise be subject to certain limitations imposed by crystal control. Calibrated for all Amateur bands 160-10 metres, fundamentals on 160 and 40 m. Ideal for Heathkit DX-40U and similar transmitters.

Kit ... **£10.17.6** Assembled ... **£15.19.6**

Q MULTIPLIER KIT. Model QPM-1



A reasonably priced Q Amplifier for the amateur and short-wave enthusiast. This self-powered unit (200-250 v. 50/60 c/s.) may be used with communications receivers to provide both additional selectivity and signal rejection.

Model QPM-1 for 470 kc/s. IF.
Model QPM-16 for 1.6 Mc/s. IF.

Kit, either model **£8.10.0**
Assembled **£12.14.0**

A WIDE RANGE OF BOOKS ON ELECTRONICS AND RADIO AVAILABLE.
Send for Lists and Prices.

By arrangement with **RECORD HOUSING** we can now supply you with any one of their large range of fully finished Equipment Cabinets. ***May we send you details?***

Please send me FREE CATALOGUE (Yes/No)...

Full details of Model(s).....

NAME .....
(Block Capitals)
ADDRESS .....

..... WW11

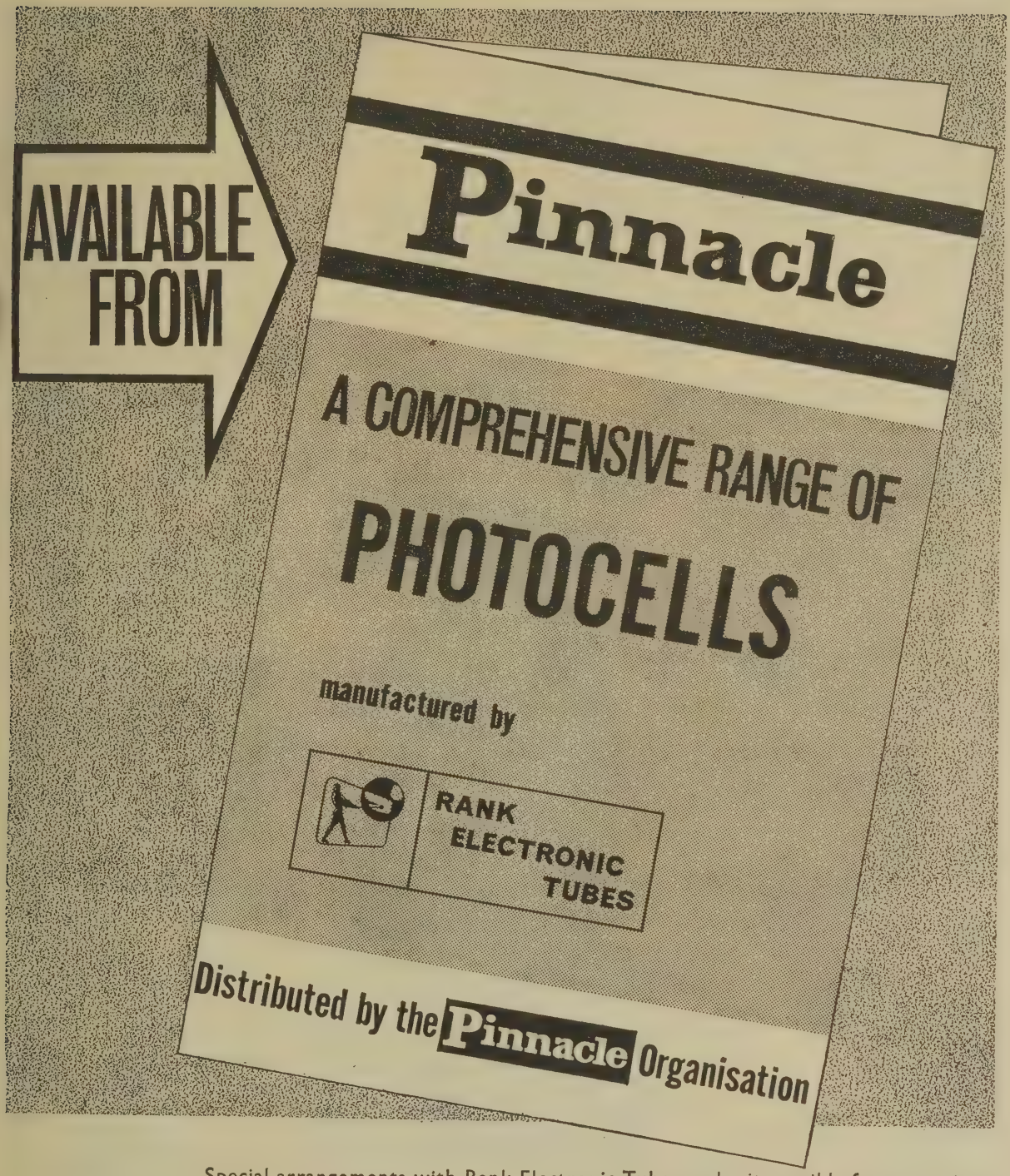
DAYSTROM LTD.

A subsidiary of the Weston Instruments Group.

DEPT. W.W.11., GLOUCESTER, ENGLAND

MANUFACTURERS OF THE WORLD'S LARGEST-SELLING ELECTRONIC KIT-SETS

14WW—019 FOR FURTHER DETAILS.



Special arrangements with Rank Electronic Tubes make it possible for us to give a rapid delivery from stock. This service is backed by the technical resources of a company with over thirty years' experience in the manufacture of standard and special photosensitive devices.

OUR LIST CONTAINS EQUIVALENTS TO OVER 150 SPECIFIC TYPES COMMONLY USED IN INDUSTRY

PINNACLE ELECTRONICS LIMITED

ACHILLES STREET, NEW CROSS, LONDON, S.E.14. Tel: TIDeway 7285

14WW—020 FOR FURTHER DETAILS.

"the choice is Yours!"

BUY A UNIT—

GOODMANS FULL RANGE SINGLE UNIT HIGH FIDELITY LOUDSPEAKERS

AXIETTE 8
(8 inch – 6 watt – 15 ohm)
The smallest full range High Fidelity loudspeaker unit produced.
Price: £4.11.0. + 14/7d. P.T.

AXIOM 10
(10 inch – 10 watt – 15 ohm)
The very popular and economical "medium size" High Fidelity loudspeaker.
Price: £5.8.6. + 17/5d. P.T.

AXIOM 301
(12 inch – 20 watt – 15 ohm)
The world's most advanced 12" High Fidelity twin cone loudspeaker.
Price: £15.4.6.

TRIAXIOM 1220c
(12 inch – 20 watt – 15 ohm)
Triple element 12" loudspeaker, spanning over 9 octaves, giving professional standard High Fidelity complete with adjustable Table control.
Price: £18.10.0.

—OR BUILD A SYSTEM—

GOODMANS MULTIPLE SPEAKER HIGH FIDELITY SYSTEMS consist of an Audiom Bass unit and pressure-driven horn-loaded mid-range and high frequency units, with crossover networks and attenuators.

AUDIOM 61 BASS
(12 inch – 20 watt – 15 ohm)
Powerful, extra high efficiency 12" unit, giving exceptional performance and control – ideal as Bass unit in 3 way systems.
Price: £14.7.8.

AUDIOM 81 BASS
(15 inch – 25 watt – 15 ohm)
Capable of handling high power with very low distortion. Ideal in High Powered 3 way High Fidelity Systems.
Price: £25.0.0.

AUDIOM 91 BASS
(18 inch – 50 watt – 15 ohm)
Exceptionally robust, heavy duty 18" loudspeaker for very high power systems.
Price: £27.10.0.

Standard Versions of all Audiom speakers are available for Public Address work and Musical Instruments (Electric guitars etc.).

(N.B. **Multiple Speaker Systems** *can also be "stage-built" using Axiom 201 or 301 as the first stage unit)*

CHOOSE THE BEST—
Choose your loudspeaker from Goodmans High Fidelity range.

COMPONENTS FOR HIGH FIDELITY LOUDSPEAKER SYSTEMS

TREBAX HIGH FREQUENCY PRESSURE UNITS

TREBAX 100
Range 2,500 – 20,000 c/s covering the treble register smoothly with very low distortion. Crossover frequency: 5,000 c/s. System power handling: 25 watts.
Price £6.10.2.

TREBAX 5K/20XL
As Trebax 100 but handling 20 watts of power in systems complete with built-in crossover network and attenuator.
Price: £7.7.0.

MIDAX MID-RANGE PRESSURE DRIVEN HORN UNIT
Range 650 – 8,000 c/s, covers the middle register with high efficiency and realism. Crossover frequencies: 950 and 5,000 c/s. System power handling: 25 watts.
Price: £9.19.6.

CROSSOVER NETWORKS
XO/5,000. Crossover frequency: 5,000 c/s. For use when adding Trebax 100 to *Axiom* unit.
Price: £2.0.11.

XO/950. Crossover frequency: 950 c/s. For use when adding Midax to Axiom and Trebax.
Price: £5.10.11.

ATTENUATOR
For use with Trebax 100 and Midax. 8-step, 0 db–12 db and "off".
Price: £2.11.2.

OR BUY A COMPLETE SYSTEM

GOODMANS COMPLETE HIGH FIDELITY LOUDSPEAKER SYSTEMS

MAXIM
The smallest *true* High Fidelity loudspeaker system made. Only 10½" x 5½" x 7½" deep. Up to 8 watts of power. No bigger than a stout book, but with a really outstanding performance.
Price: £15 + £2.10.6. P.T.

ELEGANZIA II
The super-slim system — 27" x 20" x 6½" deep. Generous power handling 15 watts. Accuracy of reproduction in the Goodmans tradition.
Price: £27.10.0.

STILL UNDECIDED? Call at your Goodmans Dealer for a demonstration or send for Goodmans High Fidelity Manual, giving full specifications and information.

FREE
Please send me a free copy of the Goodmans High Fidelity Manual
Name _____
Address _____
WW11

GOODMANS

GOODMANS INDUSTRIES LIMITED A Member of the Rentaset Group
Axiom Works, Wembley, Middlesex Telephone: WEMbley 1200
14WW—021 FOR FURTHER DETAILS.

Postage will be paid by Associated Iliffe Press

No Postage Stamp necessary if posted in Great Britain or Northern Ireland

BUSINESS REPLY CARD
Licence No. SE 591

WIRELESS WORLD,
DORSET HOUSE,
STAMFORD STREET,
LONDON, S.E.1.

CUT HERE

Wireless World

INFORMATION SERVICE FOR PROFESSIONAL READERS

NOVEMBER 1964 **2**

Please arrange for me to receive further details of the products listed, the appropriate reference numbers of which have been entered in the spaces provided below.

14WW .....14WW .....14WW .....14WW .....14WW .....
14WW .....14WW .....14WW .....14WW .....14WW .....
14WW .....14WW .....14WW .....14WW .....14WW .....
14WW .....14WW .....14WW .....14WW .....14WW .....
14WW .....14WW .....14WW .....14WW .....14WW .....

Please specify the actual product where necessary as we cannot forward general inquiries.

.....

Your Name ..... *Position Held*.....

Name of Firm.....

Address .....

.....

Nature of Business .....

CUT HERE

Irgendwelche Artikel, die
Anzeigenseiten erscheinena
eine oder mehrere der
en und die Kennummer(n)
d an den Hersteller weiter
ann direkt von ihm hören.
ufgegeben werden, müssen

HRIFT AUSFÜLLEN

In merito agli articoli
lle pagine pubblicitarie di
amo di completare una o
tando il numero o i numeri
richiesta sarà inoltrata ai
Vi risponderanno diretta-
ero devono essere regolar-

ILARE LE SCHEDE A
ATELLO

mas detalles de caulquiera
os en las paginas editoriales
mero sirvase rellenar una o
tando el numero o numeros
tas seran transmitidas a los
quienes tendran noticias
lo tiempo. Las tarjetas
ero requieren franqueo.

LETRAS MAYUSCULAS

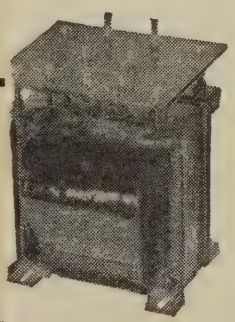
Postage will be paid by Associated Iliffe Press

No Postage Stamp necessary if posted in Great Britain or Northern Ireland

BUSINESS REPLY CARD
Licence No. SE 591

WIRELESS WORLD,
DORSET HOUSE,
STAMFORD STREET,
LONDON, S.E.1.

MERS



ione Transformers

1 R.F. Transformers

AY, ESSEX

"the choice is Yours!"

BUY A UNIT—

GOODMANS FULL RANGE SINGLE UNIT HIGH FIDELITY LOUDSPEAKERS

AXIETTE 8
(8 inch – 6 watt – 15 ohm)
The smallest full range High Fidelity loudspeaker unit produced.
Price: £4.11.0. + 14/7d. P.T.

AXIOM 10
(10 inch – 10 watt – 15 ohm)
The very popular and economical "medium size" High Fidelity loudspeaker.
Price: £5.8.6. + 17/5d. P.T.

AXIOM 301
(12 inch – 20 watt – 15 ohm)
The world's most advanced 12" High Fidelity twin cone loudspeaker.
Price: £15.4.6.

TRIAXIOM 1220c
(12 inch – 20 watt – 15 ohm)
Triple element 12" loudspeaker, spanning over 9 octaves, giving professional standard High Fidelity complete with adjustable Table control.
Price: £18.10.0.

—OR BUILD A SYSTEM—

GOODMANS MULTIPLE SPEAKER HIGH FIDELITY SYSTEMS consist of an Audiom Bass unit and pressure-driven horn-loaded mid-range and high frequency units, with crossover networks and attenuators.

AUDIOM 61 BASS
(12 inch – 20 watt – 15 ohm)
Powerful, extra high efficiency 12" unit, giving exceptional performance and control – ideal as Bass unit in 3 way systems.
Price: £14.7.8.

AUDIOM 81 BASS
(15 inch – 25 watt – 15 ohm)
Capable of handling high power with very low distortion. Ideal in High Powered 3 way High Fidelity Systems.
Price: £25.0.0.

AUDIOM 91 BASS
(18 inch – 50 watt – 15 ohm)
Exceptionally robust, heavy duty 18" loudspeaker for very high power systems.
Price: £27.10.0.

Standard Versions of all Audiom speakers are available for Public Address work and Musical Instruments (Electric guitars etc.).

(N.B. **Multiple Speaker Systems** *can also be "stage-built" using Axiom 201 or 301 as the first stage unit)*

CHOOSE THE BEST—

Choose your loudspeaker from Goodmans High Fidelity range.

COMPONENTS FOR HIGH FIDELITY LOUDSPEAKER SYSTEMS

TREBAX HIGH FREQUENCY PRESSURE UNITS

TREBAX 100
Range 2,500 – 20,000 c/s covering the treble register smoothly with very low distortion. Crossover frequency: 5,000 c/s. System power handling: 25 watts.
Price £6.10.2.

TREBAX 5K/20XL
As Trebax 100 but handling 20 watts of power in systems complete with built-in crossover network and attenuator.
Price: £7.7.0.

MIDAX MID-RANGE PRESSURE DRIVEN HORN UNIT
Range 650 – 8,000 c/s, covers the middle register with high efficiency and realism. Crossover frequencies: 950 and 5,000 c/s. System power handling: 25 watts.
Price: £9.19.6.

CROSSOVER NETWORKS
XO/5,000. Crossover frequency: 5,000 c/s. For use when adding Trebax 100 to *Axiom* unit.
Price: £2.0.11.

XO/950. Crossover frequency: 950 c/s. For use when adding Midax to Axiom and Trebax.
Price: £5.10.11.

ATTENUATOR
For use with Trebax 100 and Midax. 8-step, 0 db-12 db and "off".
Price: £2.11.2.

OR BUY A COMPLETE SYSTEM

GOODMANS COMPLETE HIGH FIDELITY LOUDSPEAKER SYSTEMS

MAXIM
The smallest *true* High Fidelity loudspeaker system made. Only 10½" x 5½" x 7½" deep. Up to 8 watts of power. No bigger than a stout book, but with a really outstanding performance.
Price: £15 + £2.10.6. P.T.

ELEGANZIA II
The super-slim system — 27" x 20" x 6¼" deep. Generous power handling 15 watts. Accuracy of reproduction in the Goodmans tradition.
Price: £27.10.0.

STILL UNDECIDED? Call at your Goodmans Dealer for a demonstration or send for Goodmans High Fidelity Manual, giving full specifications and information.

FREE

Please send me a free copy of the Goodmans High Fidelity Manual

Name .....

Address .....

WW11

GOODMANS

GOODMANS INDUSTRIES LIMITED A Member of the Rentaset Group
Axiom Works, Wembley, Middlesex Telephone: WEMbley 1200
14WW—021 FOR FURTHER DETAILS.

Postage will be paid by Associated Iliffe Press

No Postage Stamp necessary if posted in Great Britain or Northern Ireland

BUSINESS REPLY CARD
Licence No. SE 591

WIRELESS WORLD,
DORSET HOUSE,
STAMFORD STREET,
LONDON, S.E.1.

CUT HERE

Wireless World

INFORMATION SERVICE FOR PROFESSIONAL READERS

NOVEMBER 1964 2

Please arrange for me to receive further details of the products listed, the appropriate reference numbers of which have been entered in the spaces provided below.

14WW .....14WW .....14WW .....14WW .....14WW .....
14WW .....14WW .....14WW .....14WW .....14WW .....
14WW .....14WW .....14WW .....14WW .....14WW .....
14WW .....14WW .....14WW .....14WW .....14WW .....
14WW .....14WW .....14WW .....14WW .....14WW .....

Please specify the actual product where necessary as we cannot forward general inquiries.

.....

Your Name ..... *Position Held*.....

Name of Firm.....

Address .....

.....

Nature of Business .....

CUT HERE

Postage will be paid by Associated Iliffe Press

No Postage Stamp necessary if posted in Great Britain or Northern Ireland

BUSINESS REPLY CARD
Licence No. SE 591

WIRELESS WORLD,
DORSET HOUSE,
STAMFORD STREET,
LONDON, S.E.1.

Wireless World

INFORMATION SERVICE FOR PROFESSIONAL READERS

NOVEMBER 1964 1

Please arrange for me to receive further details of the products listed, the appropriate reference numbers of which have been entered in the spaces provided below.

14WW	14WW	14WW	14WW	14WW .....
14WW	14WW	14WW	14WW	14WW .....
14WW	14WW	14WW	14WW	14WW .....
14WW	14WW	14WW	14WW	14WW .....
14WW	14WW	14WW	14WW	14WW .....

Please specify the actual product where necessary as we cannot forward general inquiries.

.....

Your Name ..... *Position Held*.....

Name of Firm .....

Address .....

.....

Nature of Business .....

CUT HERE

Postage will be paid by Associated Iliffe Press

No Postage Stamp necessary if posted in Great Britain or Northern Ireland

BUSINESS REPLY CARD
Licence No. SE 591

WIRELESS WORLD,
DORSET HOUSE,
STAMFORD STREET,
LONDON. S.E.1.

CUT HERE

Wireless World

INFORMATION SERVICE FOR PROFESSIONAL READERS

NOVEMBER 1964 3

Please arrange for me to receive further details of the products listed, the appropriate reference numbers of which have been entered in the spaces provided below.

14WW	14WW	14WW	14WW	14WW .....
14WW	14WW	14WW	14WW	14WW .....
14WW	14WW	14WW	14WW	14WW .....
14WW	14WW	14WW	14WW	14WW .....
14WW	14WW	14WW	14WW	14WW .....

Please specify the actual product where necessary as we cannot forward general inquiries.

.....

Your Name.....*Position Held*.....

Name of Firm.....

Address .....

.....

Nature of Business .....

Wireless World

INFORMATION SERVICE FOR PROFESSIONAL READERS

To obtain further details of any of the coded items mentioned in the Editorial or Advertisement pages of this issue, please complete one or more of the attached cards entering the reference number(s). Your enquiries will be passed on to the manufacturers concerned and you can expect to hear from them direct in due course. Cards posted from abroad require a stamp.

PLEASE USE CAPITAL LETTERS

Pour obtenir tout àutre renseignement sur tout article mentionné dans l'Editorial ou dans les pages publicitaires de ce numéro nous vous prions de remplir une ou plusieurs des cartes ci-jointes en inscrivant le numéro ou les numéros de référence. Vos demandes de renseignement seront transmises aux fabricants intéréssés qui, entemps voulu, vous feront parvenir une réponse. Il est nécessaire d'affranchir les cartes postées de l'étranger.

PRIÈRE D'UTILISER DES CARACTÈRES D'IMPRIMERIE

Weitere Einzelheiten über Irgendwelche Artikel, die auf redaktionellen oder Anzeigenseiten erscheinena erhalten Sie, indem Sie eine oder mehrere der beigefügten Karten ausfüllen und die Kennummer(n) angeben. Ihre Anfrage wird an den Hersteller weiter geleitet, und Sie werden dann direkt von ihm hören. Karten, die im Ausland aufgegeben werden, müssen frankiert werden.

BITTE IN BLOCKSCHRIFT AUSFÜLLEN

Per ulteriori particolari in merito agli articoli menzionati nel testo o nelle pagine pubblicitarie di questo numero, Vi preghiamo di completare una o piú delle schede allegate citando il numero o i numeri di riferimento. La Vostra richiesta sarà inoltrata ai fabbricanti interessati che Vi risponderanno direttamente. Le schede dall'estero devono essere regolarmente affrancate.

SI PREGA DI COMPILARE LE SCHEDE A STAMPATELLO

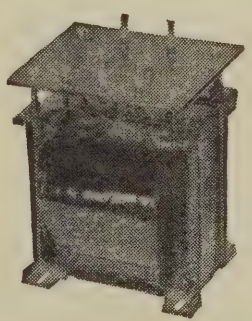
Con objeto de obtener mas detalles de caulquiera de los articulos mencionados en las paginas editoriales o de annuncios de este numero sirvase rellenar una o mas de las unidas tarjetas citando el numero o numeros de referencia. Sus consultas seran transmitidas a los fabricantes interesados de quienes tendran noticias directamente a su debido tiempo. Las tarjetas enviadas desde el extranjero requieren franqueo.

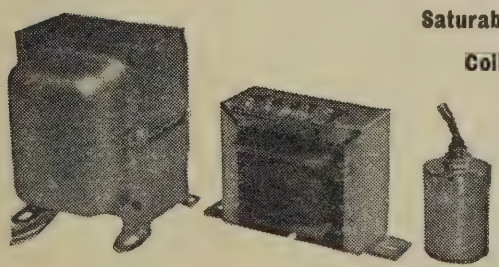
SIRVASE ESCRIBIR CON LETRAS MAYUSCULAS

10^{-12} Watts — 5 kVA

DRAKE TRANSFORMERS

Mains Transformers
Chokes
Audio Output Transformers
Audio Input Transformers
Saturable Reactors
Coils
Current Transformers
Transistor Transformers
Inverter Transformers
Screened Microphone Transformers
Wide Band R.F. Transformers





DRAKE TRANSFORMERS LTD., BILLERICAY, ESSEX

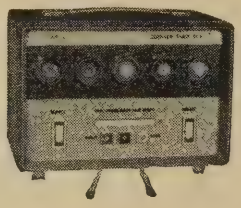
Billericay 1155

14WW—004 FOR FURTHER DETAILS.

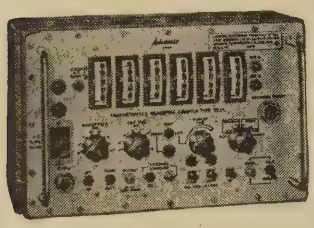
YOU CAN COUNT ON Advance

The Advance range of Timer Counters solves numerous problems. Any quality or condition which can be expressed in the timer counter language of random or regular pulses can be measured with accuracy, reliability and maximum operating economy. The ancillary equipment is designed to give even greater flexibility in the application of this range.

TC1A a fully transistorised six-digit 1 Mc/s Timer Counter with sensitivity of better than 100mV r.m.s. V.L.F. position gives frequency measurements down to Oc/s. The oven controlled crystal oscillator is accurate to 1 part in 10^6 at 25°C.
Nett price in U.K. £390

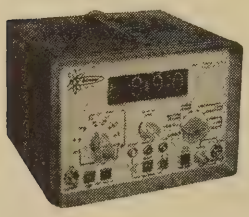


SC1 a low cost, 5 Dekatron Counter for counting regular or random pulses up to a maximum rate of 20,000 per second and time up to 999 seconds in hundredths of a second.
Nett price in U.K. £80

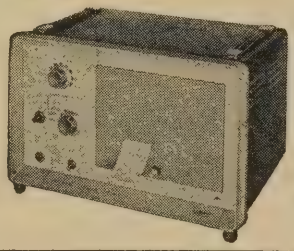


TC1S (CT463) Service approved version of the TC1A, which can be battery operated. Regular or random pulses may be counted up to a rate of one million per second. Maximum use has been made of transistors and printed circuit boards in the construction of this instrument.
Nett price in U.K. £475

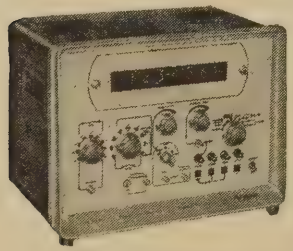
OFS1 a low cost high stability frequency standard for timer counters. It is locked onto 200Kc/s B.B.C. Light Programme and gives outputs of 100 Kc/s and 1Mc/s. Long term accuracy is 5 parts in 10^9. Simple conversion to battery operation for field use.
Nett price in U.K. £70



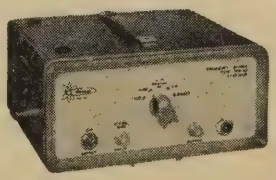
TC2A this new, low cost, general purpose Timer Counter with four-digit display can carry out all the functions of its six-digit counterparts; five gate times instantly resolve six-digit frequency measurement with automatic placing of the decimal point.
Nett price in U.K. £245



PR1 electro-mechanical printer designed to operate in conjunction with electronic counter or similar instrument. Seven in-line display is produced on 2″ paper by ordinary typewriter ribbon—8000 impressions per roll.
Nett price in U.K. £250



TC10H the seven, in-line, edge-lit indicators of this 10Mc/s Timer Counter display measurements of regular or random electrical pulses up to a maximum rate of 10 million per second. Outputs are provided to feed Advance seven-digit electro-mechanical printer PR1.
Nett price in U.K. £895



TCD40 this compact frequency divider with operating range from 1Mc/s to 40Mc/s can be used to extend the frequency range of any 1Mc/s or 10Mc/s timer counter to 40Mc/s by providing an additional divider stage.
Nett price in U.K. £110

ADVANCE ELECTRONICS LIMITED

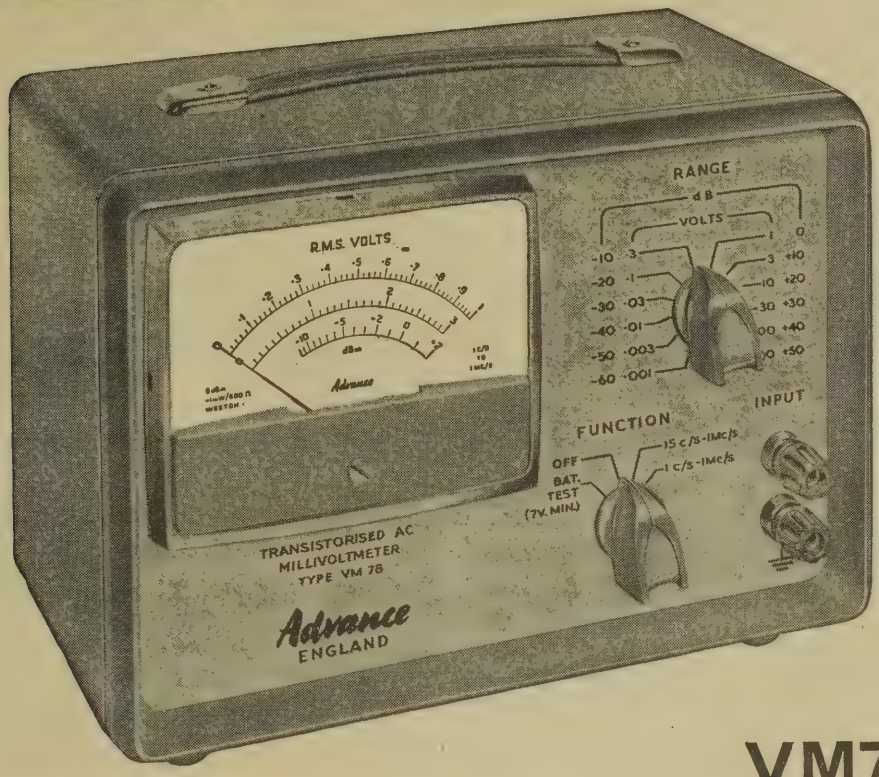
INSTRUMENT DIVISION

ROEBUCK ROAD, HAINAULT, ILFORD, ESSEX. TELEPHONE: HAINAULT 4444

SAI/11

14WW—005 FOR FURTHER DETAILS.

AC Millivoltmeters



VM77B
VM78

VM77B

1mV to 300V Full Scale in 12 overlapping ranges.
Frequency Range 15c/s to 4.5Mc/s.
Input Impedance 10MΩ 20 p.f.
Calibrated in r.m.s. volts and dB (referred to 0 dBm — 1mW in 600Ω).
Can be used as an amplifier; maximum output 1V r.m.s.; maximum gain 60dB.
Power Requirements 100 to 125V or 200 to 250V 50/60c/s 30W

NETT PRICE £49 Ex Works

VM78

Transistorised, powered by mercury cells, low noise, no hum.
1mV to 300V Full Scale in 12 overlapping ranges.
Frequency Range 1c/s to 1Mc/s.
Input Impedance 2MΩ 60 p.f.
Calibrated in r.m.s. volts and dB (referred to 0 dBm — 1mW in 600Ω)

NETT PRICE £80 Ex Works

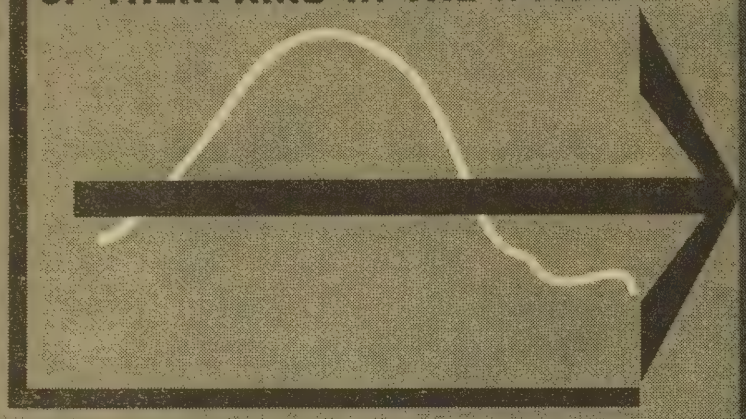
For further details please write to

ADVANCE ELECTRONICS LIMITED
(INSTRUMENT DIVISION)
Roebuck Road, Hainault, Ilford, Essex
Telephone: Hainault 4444

Electronic Instruments
Stabilised Power Supplies
Constant Voltage Transformers

14WW—022 FOR FURTHER DETAILS.

THE MOST ADVANCED STABILISERS OF THEIR KIND IN THE WORLD



series **TS**

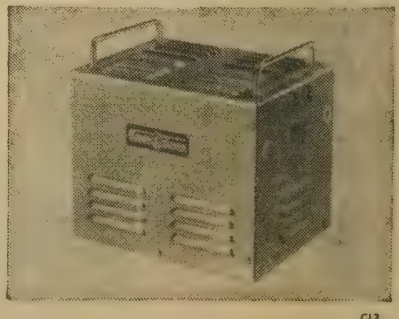
AC automatic voltage stabilisers

For high-speed voltage correction

Claude Lyons' Series TS are the most advanced electro-mechanical AC automatic voltage stabilisers available anywhere today—providing high-speed accurate stabilisation of voltage without distortion of waveform. Speed of correction is up to 60 volts/sec. with an accuracy of ±0·25%. Output voltage is unaffected by variations in supply frequency, load current or load power factor. Complete reliability is ensured by the use of a printed circuit transistor control unit employing no valves or relays. Indoor tropical rating is standard on all models.

Series TS automatic voltage stabilisers cover power ratings from 1 to 120kVA single phase and 3 to 360kVA 3 phase.

Write for illustrated technical literature to Publicity Department, Hoddesdon.



Claude Lyons

CLAUDE LYONS LTD

Valley Works, Hoddesdon, Herts
Hoddesdon 4541 Telex: 22724

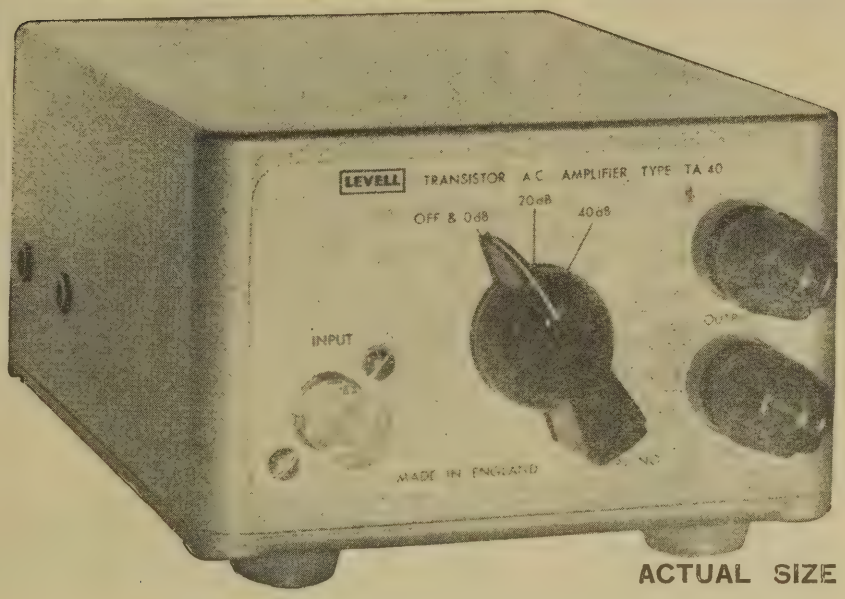
76 Old Hall Street, Liverpool 3
MARitime 1761 Telex: 62181

14WW—023 FOR FURTHER DETAILS.

Increase the sensitivity of your CRO or VTVM by 10, 100 or 1,000 TIMES

TRANSISTOR A.C. AMPLIFIER

TYPES TA40 & TA60



ACTUAL SIZE

SPECIFICATION

GAIN:	TA40: 20, and 40dB. TA60: 20, 40, and 60dB. Straight through connection on 0dB.
FREQUENCY RESPONSE:	±0.5dB, 10c/s to 250kc/s at 20dB and 40dB. 15c/s to 50kc/s at 60dB. ±3dB, 4c/s to 400kc/s at 20dB and 40dB. 10c/s to 200kc/s at 60dB.
OUTPUT VOLTS:	1.5V r.m.s. into 10kΩ.
OUTPUT IMPEDANCE:	80Ω approx. at 20dB and 40dB. 150Ω approx. at 60dB.
NOISE LEVEL:	50μV r.m.s. equivalent input at 20dB and 40dB with 100kΩ source. 30μV r.m.s. equivalent input at 60dB with 100kΩ source.
INPUT IMPEDANCE:	3MΩ and 10pF at 20dB and 40dB. 0.25MΩ and 50pF at 60dB.
SUPPLY:	Self-contained 9V battery, life 1000 hours, or A.C. Mains when a Power Unit is fitted.
SIZE:	2½in. high x 4in. wide x 5½in. deep.
WEIGHT:	2½ pounds.

LEVELL
PORTABLE INSTRUMENTS

Price complete with battery TA40 ..... **£24**

" " " " TA60 ..... **£27**

Mains Power Supply Unit **£9.0.0**

Fully detailed leaflets available on our complete range of portable instruments

LEVELL ELECTRONICS LIMITED

Park Road, High Barnet, Herts. *Telephone: BARnet 5028*

14W W—024 FOR FURTHER DETAILS.

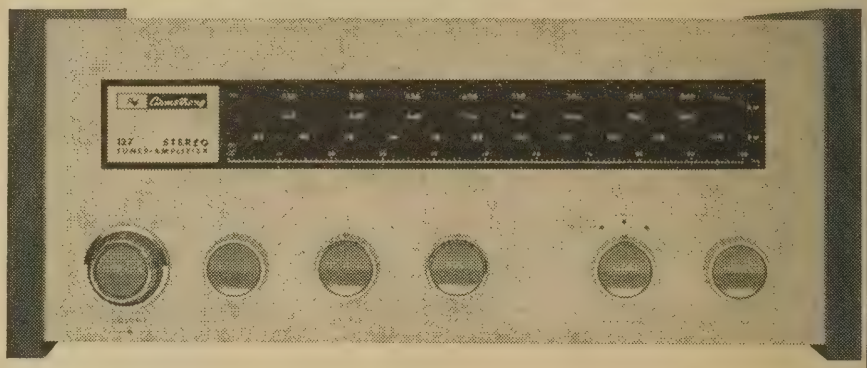
NEW NOT JUST 1 BUT 2

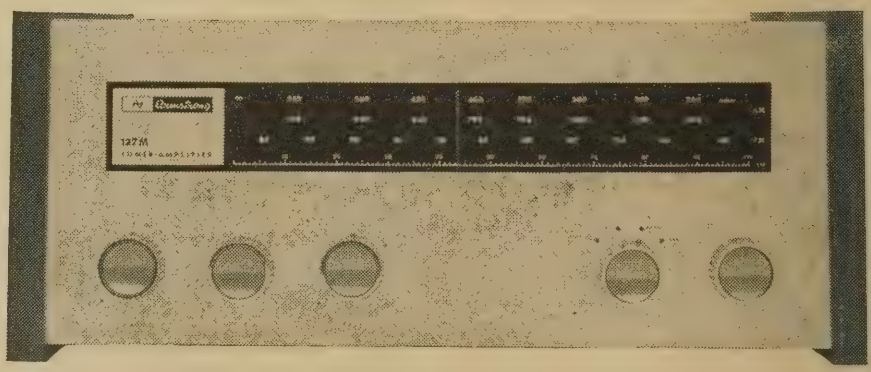
NEW TUNER - AMPLIFIERS

NEW NEW NEW NEW NEW NEW NEW NEW NEW NEW NEW NEW NEW NEW

Having AM-FM tuner sections identical to our expensive range (see other advertisement in this magazine), but with amplifier sections designed for those whose power requirements are more modest, these units are ideal as the basis of a relatively inexpensive high fidelity system, or good quality radiogram.
Each unit provides for AM-FM radio, record reproduction, tape recording and playback. With the simple addition of an Armstrong Multiplex Decoder the stereo model is ready for stereo broadcast reception.
Either unit may be built into your own cabinet or housed in our handsome case. For full details and list of over 300 stockists post coupon or write, (quote IWW.11.64) Model 127 Stereo (top picture), £37/10/0. Model 127M Mono (bottom picture), £26/10/0. Both models. Optional case, Teak and Vinyl hide, £3/10/0.

Wright & Connor





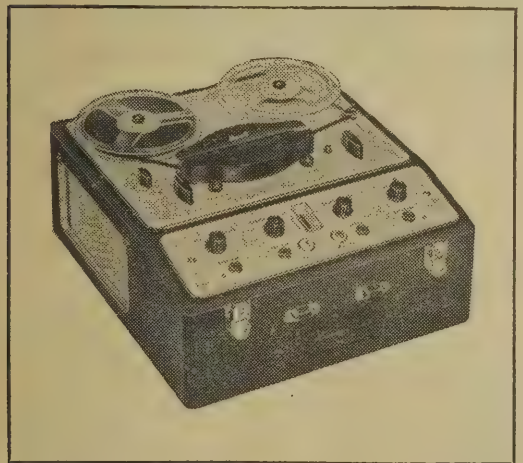
Armstrong Audio Ltd.
Warlters Road,
London, N.7
telephone NORTH 3213

name_____
address_____
_____
I.WW.11.64

Armstrong

14WW—025 FOR FURTHER DETAILS.

. . . . with a BRENELL tape recorder



The immediate, unerring response to the controls of a Brenell tape recorder only goes to emphasise the precision engineering and clever electronics which are built into each machine.

Record and playback performances are as impeccable as the following specification conveys:—

MARK 5 Series 2

4 record/playback speeds, 1⅞, 3¾, 7½ and 15 ips ● frequency correction at all speeds ● 3 independent motors (capstan motor-hysteresis synchronous) ● exceptionally low "wow and flutter" content ● double gapped ferrite erase head to minimise erase noise ● narrow gapped record/playback head for extended frequency response ● pause control ● superimpose control ● recording level indicator (meter available) ● up to 8½in. dia. reels (Mark 510 Series 2—10½in. dia. N.A.B. and standard reels) ● fast rewind (1,200ft. in 45 secs.) ● digital rev. counter.

For full details of the complete range of mono and stereo models write to the sole manufacturer:—

Brenell

PLEASE NOTE OUR NEW ADDRESS

BRENELL ENGINEERING CO. LTD.
231/5 Liverpool Road, London, N.1
Telephone: NORth 8271 (5 lines)

GD 814

14WW—028 FOR FURTHER DETAILS.

and Now-
a Fully Transistorised Walkie-Talkie!

the PYE Bantam
TWO-WAY RADIOTELEPHONE

Once again in the tradition of the outstanding Cambridge and Vanguard Radiotelephones, Pye have produced the Bantam, a brilliant fully transistorised Walkie-Talkie.

- Fully transistorised Transmitter and Receiver
- Long endurance with Rechargeable or Dry Batteries
- Crystal Filter selectivity
- Reliability and accessibility of components
- Very high performance Receiver
- Lightweight 4 lbs. (1.82 kg.)
- Frequency Band 25-174 Mc/s.
- Weatherproof
- Approved by G.P.O. to spec. W6345

Tel: TEVERSHAM 3131

PYE TELECOMMUNICATIONS LTD. CAMBRIDGE, ENGLAND · *Telex No. 81166*

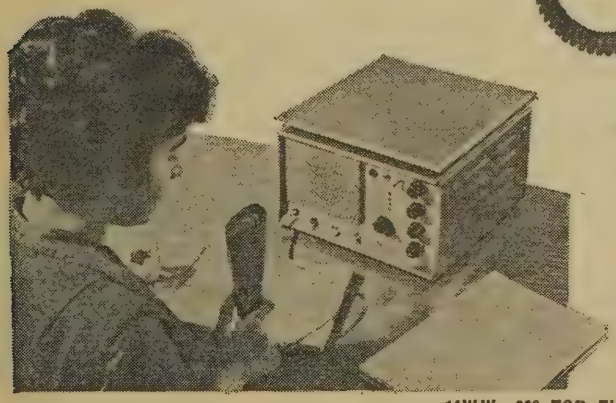
14WW—027 FOR FURTHER DETAILS.

PYE

SINGLE SIDEBAND

RADIOTELEPHONE SSB 125

The world's most competitive Single Sideband Radiotelephone—the SSB 125 is suitable for fixed or mobile operation and is the most economic equipment for long distance communication available today.



Features

- 125 watts p.e.p. output
- 4 switched channels
- Transistor DC or AC power pack
- Crystal filter selection of sidebands

PYE TELECOMMUNICATIONS LTD.
CAMBRIDGE · ENGLAND
Telephone: **Teversham 3131**

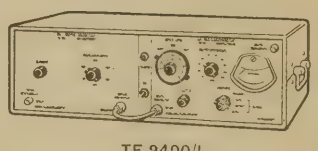
14WW—028 FOR FURTHER DETAILS.

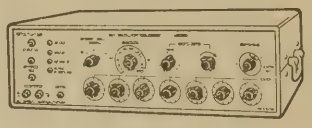
SPECIAL PROBLEMS CALL FOR—

TF 1417/2

SPECIAL COUNTER METHODS

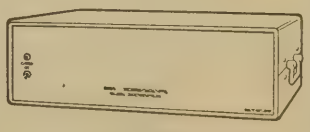
with Marconi Instruments Counters Types TF 1417/2 and TF 2401

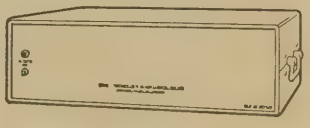

TF 2400/1


TF 2403

TF 2402

TF 2404


TF 2403


TF 2406

10 Mc/s COUNTER/FREQUENCY METER Type TF 1417/2

Fully transistored. Display period set independently of time base, self-cancelling or held until reset manually. Frequency range: 0 to 10 Mc/s. Time: 0.2 μsec and longer. Period: 0 to 5 Mc/s. Crystal error: ±3 x 10-7 long term. Input level 250 mV to 100 V r.m.s. Attenuator factors: 1—5—10—20. Outputs: time pulse base intervals 0.1 c/s to 1 Mc/s in decades, standard frequencies 1 and 10 Mc/s and printer (BCD).

10—510 Mc/s CONVERTER Type TF 2400/1

Increases sensitivity as well as frequency range of the Type TF 1417/2 Counter/Timer. The TF 2400/1 incorporates two separate units: a 10-110 Mc/s Converter Type TF 2400 which can be supplied alone, and a 110-510 Mc/s Converter Type TM 7164. If the second unit is not supplied, a blank panel is fitted in its place. Sensitivity is 10 mV r.m.s. over counter range 20 kc/s to 10.5 Mc/s and converter range 10-110 Mc/s, and 100 mV over converter range 110-510 Mc/s. Input voltage is adjusted by attenuator and provision is made to tune input signals if increased definition is required.

ANALOGUE OF DIFFERENCE UNIT Type TF 2405

When the output from a Marconi Instruments counter, comprising up to seven digits in 1—2—4—8 BCD, differs from a pre-selected seven-digit number by any number up to ± 999 on any three successive digits, this equipment delivers a d.c. current or voltage equivalent to the difference, suitable for recording or control purposes. This output is normally positive when the input from the counter is high and negative when the input from the counter is low, but a reversing switch is provided. Signal lamps indicate the high or low condition, and also show when the difference is greater than 999.

DIGITAL-TO-ANALOGUE CONVERTER Type TF 2402

A d.c. voltage or current suitable for recording or remote control equipment is generated by this unit, as the equivalent of the last two or of any three successive digits selected from the BCD output of Marconi Instruments counters (or any other digital equipment having similar output code characteristics).

OUT-OF-LIMITS INDICATOR Type TF 2404

A High/In/Low discriminator and control system for use with Marconi Instruments counters (or any digital equipment with similar output characteristics). Three relays, suitable for controlling power circuits, are operated according to whether the output from digital equipment is above, within or below two pre-selected limits; and three signal lamps indicate the same conditions. Upper and lower limits can be pre-set to any seven-digit number between 0,000,000 and 9,999,999.

DIGITAL CODE CONVERTERS Type TF 2403 Series

These units convert the parallel-entry four-line 1—2—4—8 BCD output from Marconi Instruments counters (or any equipment with similar output characteristics) to alternative codes for the operation of particular types of printer or data handling equipment. Models are available for use with interrogation type printers and for equipment using parallel-entry four-line 1—2—2—4 BCD. Provision is made for other output codes.

COUNTER TIME-BASE DISTRIBUTION UNIT Type TF 2406

This pulse distribution amplifier enables up to eight slave counters to be operated from a common time-base derived from a ninth counter or from an external source. It may also be used for the distribution of pulses to and from other equipment having appropriate characteristics.

A GOOD NAME FOR GOOD MEASURE

If you have any problem which might be solved by electronic counting or timing techniques, please get in touch with Marconi Instruments Limited

Head Office—Home and Export Sales
Marconi Instruments Limited, St. Albans, Herts., England.
Telephone: St. Albans 59292

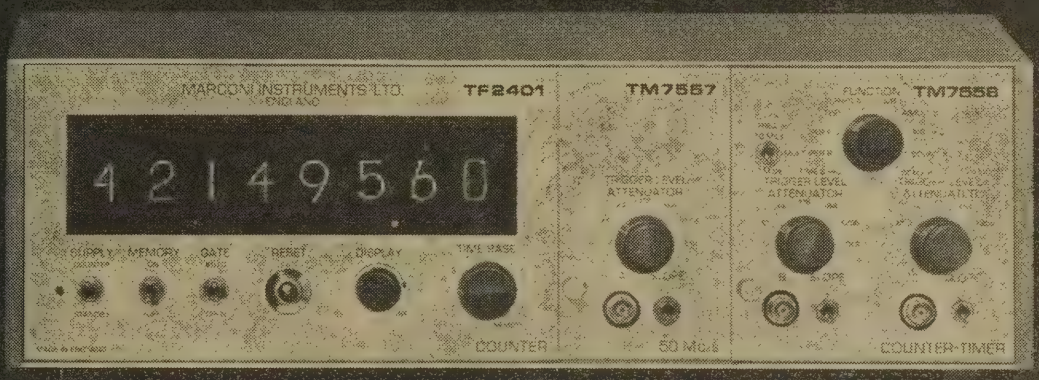
Area Offices at—Bristol, Harrogate and London

MARCONI INSTRUMENTS

TC271

14WW—029 FOR FURTHER DETAILS.

BUILT-IN PERFORMANCE



Marconi Instruments Counter Type TF 2401

Virtually every application of counter technique is within the scope of Marconi Instruments Type TF 2401 Counter: frequency measurement; frequency and multiple frequency ratio comparison; period and multiple period measurement; time interval measurement with internal or external time base; scaling down of applied signals; operation as an integrating digital voltmeter or digital phase angle meter; printer drive—or straight counting up to 100 Mc/s direct and up to 600 Mc/s using heterodyne techniques.

The basic chassis of the TF 2401 has been designed to accept not only the plug-in frequency and function modules and add-on function units manufactured by Marconi Instruments Limited, *but also all the special-purpose modules developed by the Computer Measurements Company of America for their Series 800 counters.* This unique technical exchange agreement, involving a compatible system of modular construction and solid state circuit technique, makes the TF 2401 the most flexible and versatile instrument of its kind available—a long-term investment in the best of British and American thinking and technical development in the vital field of electronic counters.

BASIC COUNTER UNIT
Type TF 2401

8-digit in-line display with memory, automatic decimal point and unit indicator, giving direct readout in c/s, kc/s or Mc/s for frequency measurements in sec, msec or μsec for period or time interval measurements, and scaling factor for multiple ratio, multiple period and scaling. Digit display time continuously variable from 0.1 to 5 sec or held indefinitely until manually reset.

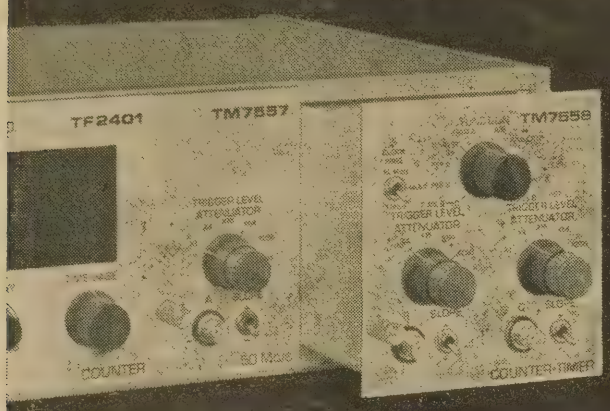
Precision 1 Mc/s crystal oscillator with a stability of $\pm$ 1 x 10^{-8} per day ($\pm$ 3 x 10^{-9} short term). Gate times between 1 μsec and 100 sec or standard frequencies between 1 c/s and 10 Mc/s in decade steps. Self-check facility for all time base and readout decades.

The integral power supply feeds the plug-in units. Connection to the mains supply energises the thermostatically controlled crystal oven immediately, even if the counter is not switched on.

Outputs: Time base pulses 0.01 c/s to 1 Mc/s in decades (0 to -5V), standard frequencies 1 and 10 Mc/s (0.5V r.m.s.) and printer (B.C.D.).

14WW—030 FOR FURTHER DETAILS.

PLUG-IN VERSATILITY



RANGE UNIT
Type TM 7557

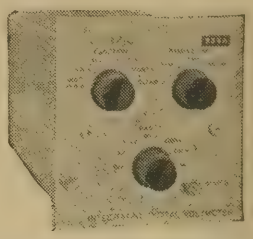
Usable up to 50 Mc/s. This unit determines the frequency range of the basic counter and is required to operate with any of the function modules described here. The Range Unit incorporates a switched attenuator (X1 to X256), and trigger slope and level controls for a single channel input (A). Sensitivity is 0.1 V r.m.s. (slightly reduced between 1 c/s and 10 c/s). Inputs up to 500 V peak to peak can be accepted via the attenuator.

A 100 Mc/s decade is available from the CMC range.

COUNTER/TIMER FUNCTION UNIT
Type TM 7558

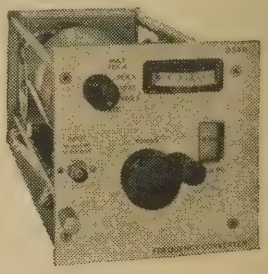
This unit incorporates independent attenuators, and slope and trigger level controls for two additional inputs (B and C) which have similar characteristics to the A input of the Range Unit up to 10 Mc/s. The Counter/Timer Unit controls the signal paths of all three inputs and of the internal standards of the basic counter.

With the internal time base in use, the TF 2401 counter will measure: (i) the frequency of the input at A, or (ii) the time for 1 to 10^8 periods (in decade steps) of the input at B, or (iii) the time interval between signals at B and C. Without the internal time base, the counter will (iv) make a direct count of the input at A, or (v) count the input at B divided by 1 to 10^{16} in decade step-, or (vi) measure the ratio of the frequency at A divided by 1 to 10^8 times the input at B (in decade steps), or (vii) count the input signals at A in the period between signals at B and C. A self check facility is also provided.



INTEGRATING DIGITAL VOLTMETER Model 835A

Basically an analogue-to-digital converter, this unit converts voltage to frequency with a linearity of 0.025% providing direct reading digital voltage measurements on the TF 2401 counter, accurate to ± 0.1% of range maximum. When used as a digital voltmeter, the TF 2401 can be employed in conjunction with a recording system, out-of-limits indicator or automated test procedure. Five manually selected ranges are provided, with maxima of 0.1—1—10—100—1000 V d.c. and with automatic decimal point and polarity indication. The input resistance is 100 kΩ on the 0.1 V range, and 1 MΩ on all other ranges.



50-600 Mc/s CONVERTER
Model 834B

Accurate frequency measurements in the u.h.f. bands can be carried out by using this heterodyne converter unit with the TF 2401 counter. In operation a ten-digit readout is obtained, the first two digits being presented on the dial of the Converter Unit and the remaining eight digits on the counter readout. No charts, graphs or dial interpolations are necessary.

DIGITAL PHASE METER
Model 838A

Enables the phase angle between two signals of the same frequency in the range 10 c/s to 100 kc/s to be measured and displayed directly in degrees on the TF 2401 counter. The two inputs are completely independent, with separate attenuators (X1 to X256) and trigger slope switches. Each has an impedance of 0.1 MΩ with 30 pF in shunt. Sensitivity: 100 mV r.m.s. to 100 V r.m.s. maximum without attenuator, a.c. coupled. The trigger level is fixed at zero. Phase angle range; 1° to 360° with automatic decimal point. Time base settings: 0.1, 1 and 10 seconds.

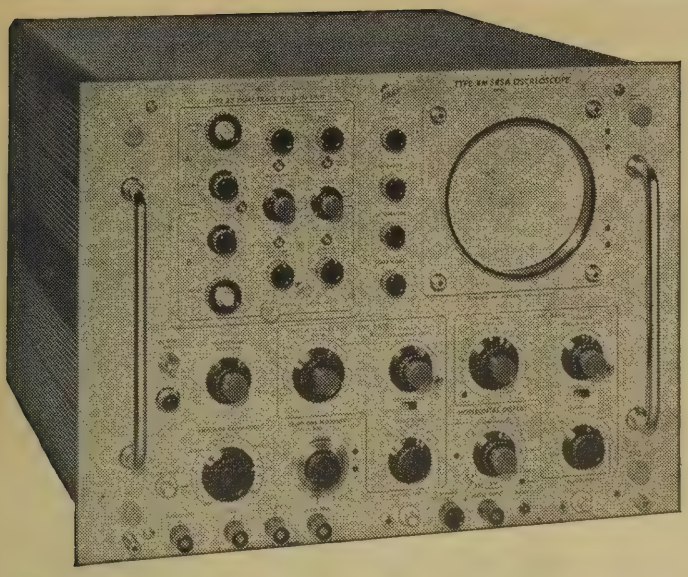
A GOOD NAME FOR GOOD MEASURE

Please write to Marconi Instruments Limited for further technical information about the TF 2401 Counter and the compatible range of units manufactured by Computer Measurements Company.

Head Office—Home and Export Sales
Marconi Instruments Limited, St. Albans, Herts., England.
Telephone: St. Albans 59292

Area Offices at—Bristol, Harrogate and London.

MARCONI INSTRUMENTS



85 Mc/s

TEKTRONIX 585A

NEW MEASUREMENT CONVENIENCE FOR HIGH-SENSITIVITY, WIDE-BAND, DUAL-TRACE APPLICATIONS

DUAL-TRACE OPERATION with 4 operating modes and independent controls for each channel—for individual attenuation, positioning, inversion, and ac or dc coupling as desired.

PASSBAND typically DC-TO-85 Mc/s (3-db down) at 100 mv/cm (12-db down at 150 Mc/s), and typically DC-TO-80 Mc/s (3-db down) at 10 mv/cm.

CALIBRATED SENSITIVITY in 9 steps from 100 mv/cm to 50 v/cm, and in 10X Amplifier Mode, from 10 mv/cm to 5 v/cm, variable between steps.

INTERNAL AND EXTERNAL TRIGGERING to 150 Mc/s.

SWEEP RANGE from 10 nsec/cm to 2 sec/cm.

SINGLE SWEEP PHOTOGRAPHY at 10 nsec/cm.

BRIGHT, HIGH-RESOLUTION DISPLAY with small spot size.

CONVENTIONAL PASSIVE PROBES for convenience.

PLUS

COMPATIBILITY WITH 17 LETTER-SERIES PLUG-INS to permit differential, multi-trace, sampling, other laboratory applications—when used with Type 81 adaptor.

AVAILABLE BENCH MOUNTING 585A—£743 or RACK MOUNTING RM585A—£788
TYPE 82 DUAL-TRACE PLUG-IN UNIT—£276

Full details and prices from

Tektronix U.K. Ltd. *Beaverton House · Station Approach · Harpenden · Herts*
Telephone: Harpenden 61251 · Telex: 25559

For overseas enquiries:—
TEKTRONIX Ltd, Albany House, St. Peter Port, Guernsey, C.I. · TEKTRONIX CANADA Ltd, Montreal, Quebec & Toronto (Willowdale), Ontario
TEKTRONIX AUSTRALIA PTY. Ltd, P.O. Box 488, Sydney, New South Wales
TEKTRONIX INTERNATIONAL A.G., P.O. Box 57, Zug, Switzerland · TEKTRONIX INC, P.O. Box 500, Beaverton, Oregon. USA

14WW—032 FOR FURTHER DETAILS.

CLARK

AIR OPERATED TELESCOPIC MASTS

SOME APPLICATIONS

Radio Aerials
Meteorological Instruments
Microphones
T.V. Cameras
Floodlighting
Aircraft Landing Beam checks and calibration

BRIEF INFORMATION

Extended heights: 16-100 feet
Lifting Capacity: 1-200 lb.
Material: High Tensile Light Alloy

Full range of attachments for mounting masts on vehicles or in open country
Air supply taken from hand-pump, air compressor or air bottle through special control valves

EACH MAST BACKED BY THE EXPERIENCE WHICH HAS MADE CLARK THE FIRST CHOICE

Write for Pocket Catalogue today.

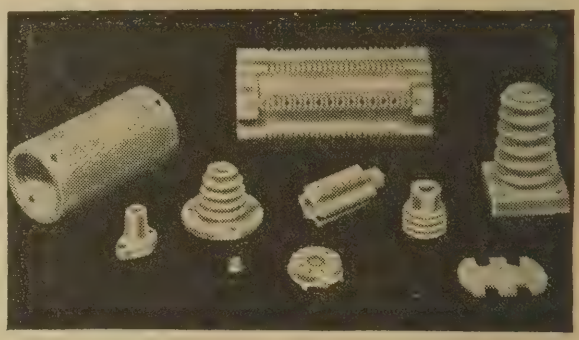
A. N. CLARK (ENGINEERS) LIMITED
Binstead, Ryde, Isle of Wight
(Formerly of Merton, London, S.W.19)

Telephone: RYDE 3691 Telegrams: TELEMAST RYDE

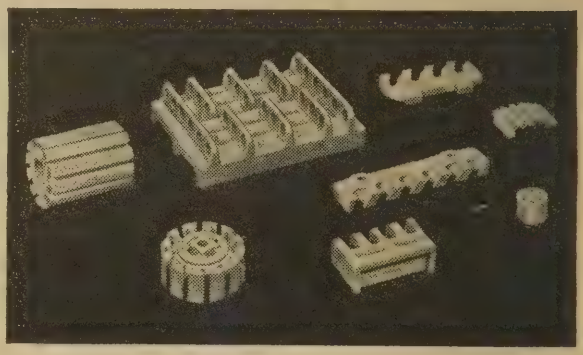
14WW—033 FOR FURTHER DETAILS.

Bullers CERAMICS

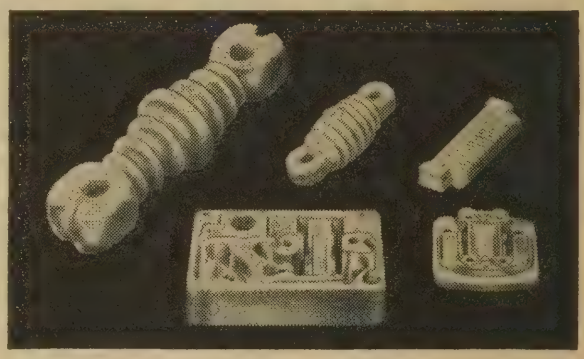
for the **ELECTRONIC INDUSTRY**
(and Electrical Appliance Manufacture)



Frequelex—for high-frequency insulation.



Refractories for high-temperature insulation



Bullers porcelain for general insulation purposes.

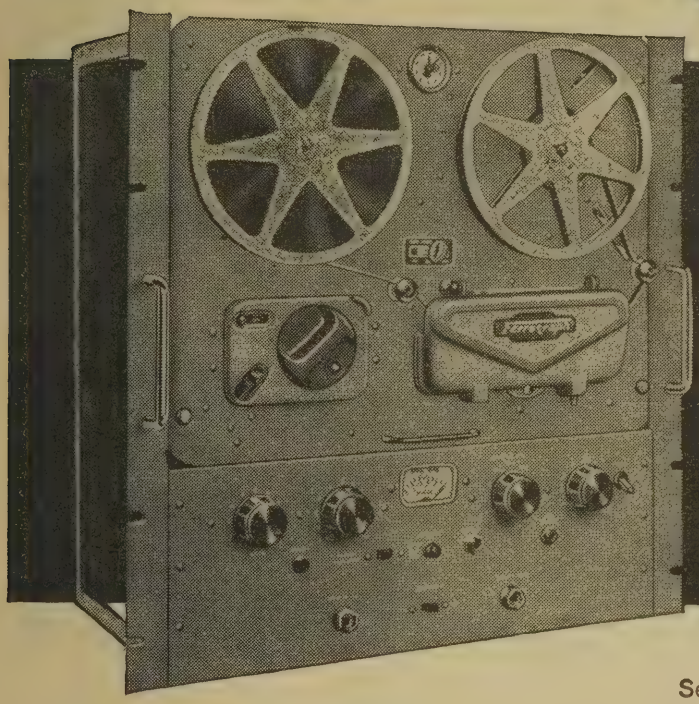
Meticulous care in manufacture, high quality material, with particular attention applied to *dimensional precision and accuracy*, explain the efficiency and ease of assembly when using Bullers die pressed products. *Write today for detailed particulars.*

BULLERS LIMITED

Milton, Stoke-on-Trent, Staffs.
Phone: Stoke-on-Trent 54321 (5 lines)
Telegrams & Cables: Bullers, Stoke-on-Trent
London Office: 6 Laurence Pountney Hill, E.C.4
Phone: MANsion House 9971

14WW—034 FOR FURTHER DETAILS.

Ferrograph



SERIES Y RECORDERS

Series "Y" instruments are housed in strong metal cases and, in some instances, can be rack-mounted. They are intended for those engaged in scientific research and industrial pursuits.

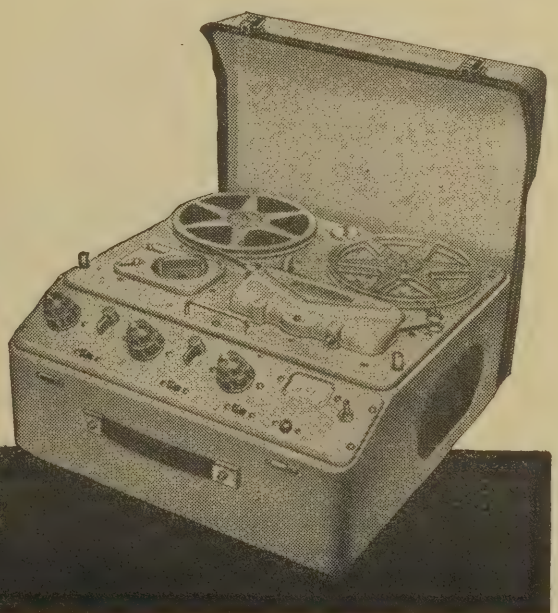
YD5 SINGLE CHANNEL RECORDERS

Model	Tape Speeds	Voltage	Frequency
YD5A	7½, 3¾ and 1⅞ i.p.s.	100/250V	50 c.p.s.*
YD5AH	15 and 7½ i.p.s.	100/250V	50 c.p.s.*
YD5B	7½, 3¾ and 1⅞ i.p.s.	100/250V	50 c.p.s.*
YD5BH	15 and 7½ i.p.s.	100/250V	50 c.p.s.*

*60 c.p.s. to order

Y500 DOUBLE CHANNEL RECORDERS

Model	Tape Speeds	Voltage	Frequency
Y532U	7½, 3¾ and 1⅞ i.p.s.	200/250V	50 c.p.s.
Y532A	7½, 3¾ and 1⅞ i.p.s.	117V	60 c.p.s.
Y532E	7½, 3¾ and 1⅞ i.p.s.	110V	50 c.p.s.
Y522UH	15 and 7½ i.p.s.	200/250V	50 c.p.s.
Y522HA	15 and 7½ i.p.s.	117V	60 c.p.s.
Y522HE	15 and 7½ i.p.s.	110V	50 c.p.s.



Send for details to:

THE FERROGRAPH COMPANY LTD

84 BLACKFRIARS ROAD, LONDON, S.E.1

Telephone: WATerloo 1981

14WW—035 FOR FURTHER DETAILS.

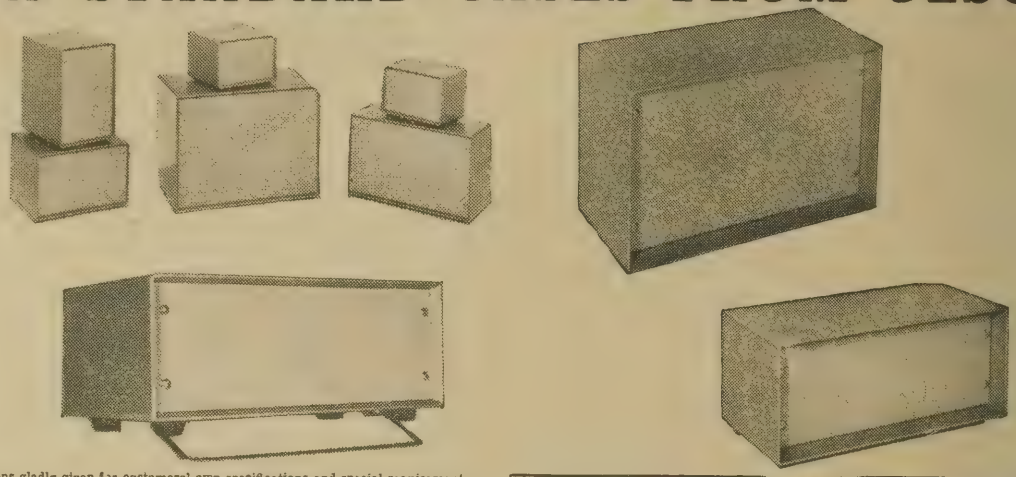
Radiospares Ltd.

FOR ELECTRONIC COMPONENTS—BY RETURN

TRADE ONLY

14WW—036 FOR FURTHER DETAILS.

NEW STANDARD CASES FROM OLSON



Quotations gladly given for customers' own specifications and special requirements

WRITE FOR FURTHER DETAILS TO:—

OLSON ELECTRONIC LIMITED, 54, Myddleton Street, LONDON, E.C.1. Telephone: TERminus 8081

14WW—037 FOR FURTHER DETAILS.

SOUND REPRODUCTION

A brilliant new range
of small speakers by R & A
3″ x 3⅜″ round
6″ x 4″ and 8″ x 5″ elliptical
5″ pincushion.
And a new range of
8″ x 12″ units giving
higher fidelity at little
more than standard prices.

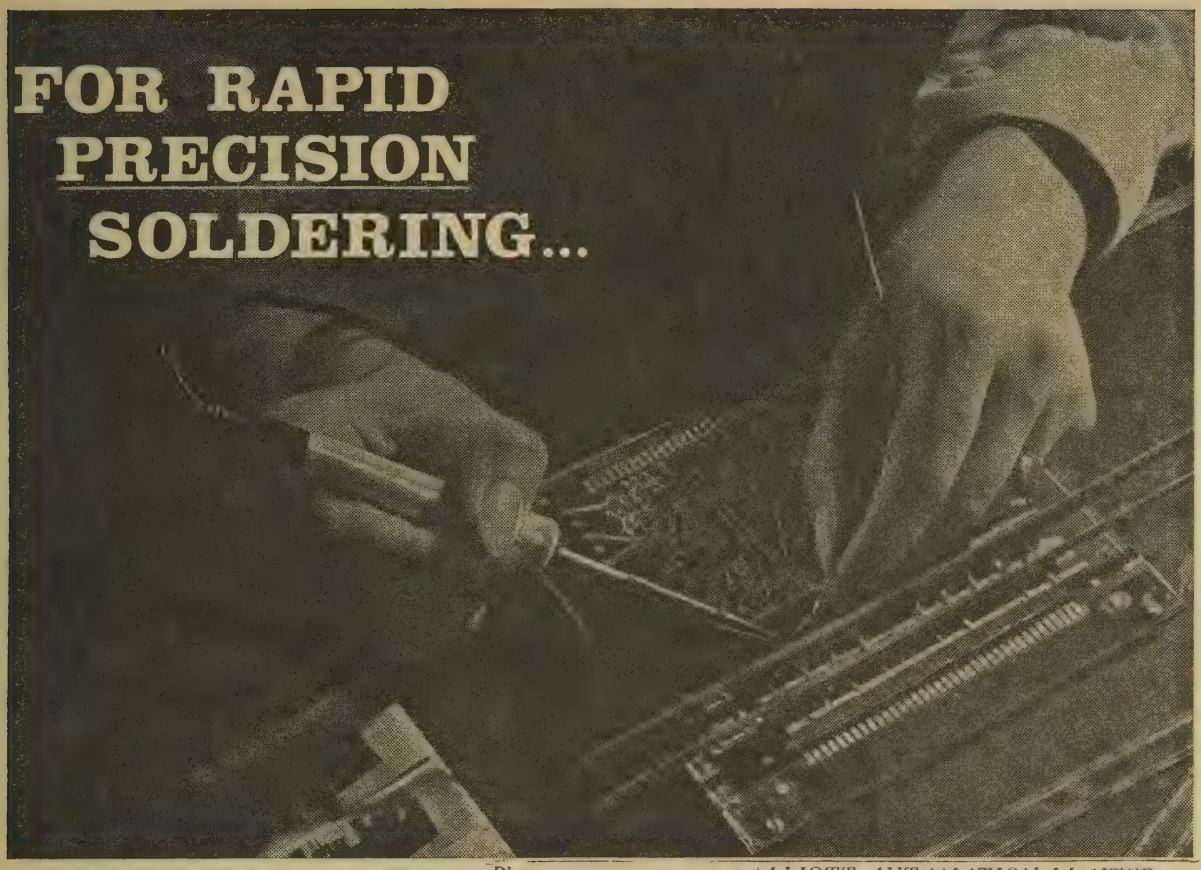
R&A

LOUD SPEAKER MANUFACTURERS TO THE RADIO INDUSTRY SINCE 1930

REPRODUCERS AND **AMPLIFIERS** LTD.

WOLVERHAMPTON, ENGLAND.

14WW—088 FOR FURTHER DETAILS.



Photograph by courtesy of ELLIOTT AUTOMATION LIMITED

CHOOSE ANTEX * PRECISION SOLDERING IRONS

...used by experts everywhere!

ANTEX IS PURPOSE-DESIGNED
for speed and efficiency in soldering Printed Circuits, Transistors, Micro-Miniature Assemblies, Deaf-Aid Equipment and similar products.

ANTEX INCREASES PRODUCTION
ANTEX Irons weigh only 2-3 ounces. Streamlined to give absolute finger-tip control and ensure increased production of 5% to 10% compared with ordinary soldering irons.

ANTEX CUTS PRODUCTION COSTS
So easy to use — ANTEX reduces operational fatigue, with resulting drop in reject output. ANTEX, having the lowest leakage current of any miniature iron, virtually eliminates all risk of damage to transistors.

ANTEX FOR RELIABILITY
Guaranteed for 1000 hours' continuous production —on fine work giving a potential of well over a quarter of a million trouble-free soldering points.

ANTEX BITS are really INTERCHANGEABLE
ANTEX patent design gives instant interchangeability of bits—as often as you like—without damaging the iron!

* *Latest in the ANTEX Range is Model C240N—a giant in power performance—a midget in compact construction! FITTED WITH LONG-LIFE "FERRACLAD" BITS.*

For more details fill in and post this coupon TODAY!

ANTEX LIMITED — SPECIALISTS in Soldering Appliances

GROSVENOR HOUSE, CROYDON, SURREY
Tel: MUNICIPAL 2774

Please send details and prices of the ANTEX Range of Precision Soldering Irons.

NAME .....

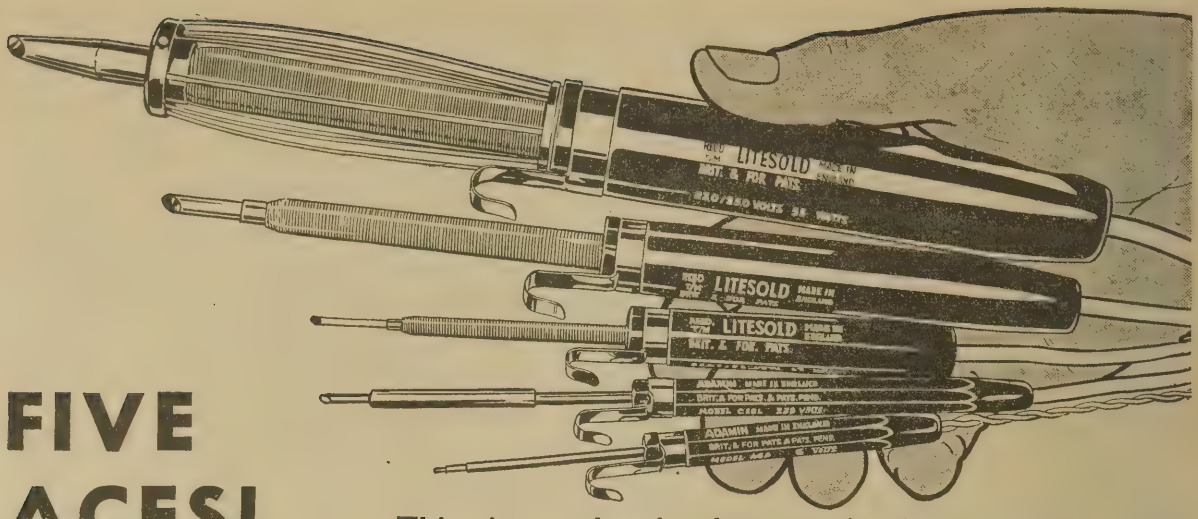
ADDRESS .....

.....

.....

STATUS .....

WW



FIVE ACES!

This is a hand that can't be beaten. Five models from our tremendous range of soldering instruments. Superb performance. Amazingly compact. Developed to simplify YOUR soldering. Copper bits for greatest speed. Permatip bits for long life. May we deal you in ?

Brochure W5 post free on request.

LIGHT SOLDERING DEVELOPMENTS LTD., 28, Sydenham Road, Croydon, Surrey.
Telephone: CROydon 8589

14WW—040 FOR FURTHER DETAILS.

SUPERIOR ELECTRON GUNS

FIRST CHOICE— THE WORLD OVER!

Total SUPERIOR experience in engineering, design and manufacture of electron guns is always one step ahead of the field.

The result, SUPERIOR continues to maintain a wide margin of leadership in "Space Age" quality standards that surpass original equipment manufacturers and rebuilders requirements in electron guns for COLOR and BLACK and WHITE COMMERCIAL TV TUBES — INDUSTRIAL — MILITARY — SPECIAL PURPOSE and EUROPEAN tube types.

SUPERIOR serves a world wide market— is ready to serve you now! Write for complete catalog of facilities and types.

SUPERIOR has the facilities to supply 110° hard pin and 90° and 110° soft wire stems to manufacturers who assemble their own guns. Your inquiries are invited.

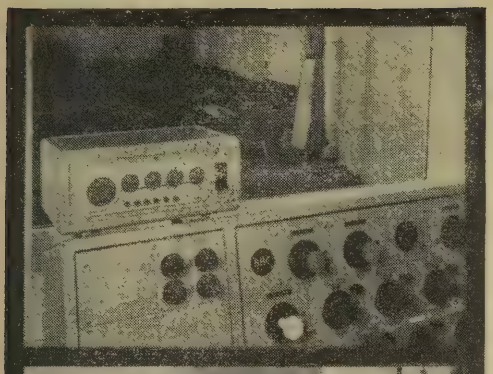
© 1964 Superior Electronics Corp.

SUPERIOR ELECTRONICS Corporation

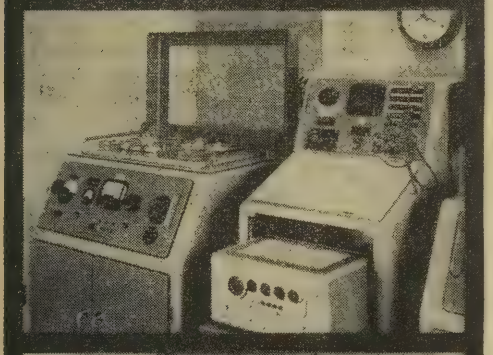
CLIFTON, N. J., U. S. A. / CABLE ADDRESS: "SECO" CLIFTON, N. J., U. S. A.

LONDON STOCKISTS:
ELECTRODE WELDING CO., LTD.
Jubilee Works—Cobbold Road—
Willesden, London NW 10

14WW—041 FOR FURTHER DETAILS.

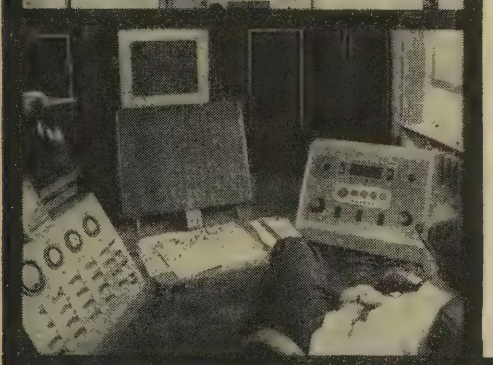


A studio control room where the programmes are passed through a QUAD control unit for special balancing.



Quality Check Room. Programmes originating from abroad are here passed through a QUAD control unit and power amplifier where they are filtered and balanced for optimum quality prior to transmission.

Off the air monitoring. QUAD tuners provide a continuous check on transmissions.



. . . . and in your own home, too. Quad for the closest approach to the original sound.

BRITISH BROADCASTING

In Britain and throughout the world, several thousands of QUAD products help to provide the best in broadcasting and recording. This same equipment is used in many more thousands of homes where people listen to music.

Send a postcard for full details of the QUAD range.

Photographs by kind co-operation of the British Broadcasting Corporation

QUAD

for the closest approach to the original sound

The Quality Monitor room. Quad used for a final check on the overall quality of British Broadcasting.

THE ACOUSTICAL MANUFACTURING CO. LTD.
Huntingdon, Hunts.

14WW—042 FOR FURTHER DETAILS.

WEYRAD

COILS AND I.F. TRANSFORMERS IN LARGE-SCALE PRODUCTION FOR RECEIVER MANUFACTURERS

P.9 SERIES 10 mm. × 10 mm. × 14 mm. Ferrite cores 6 mm. 472 kc/s operation. Single-tuned I.F.s and Oscillator Coils.

P.55 SERIES 12 mm. × 12 mm. × 20 mm. Ferrite cores 4 mm. 472 kc/s operation. Single-tuned I.F.s and Oscillator Coils.

T.41 SERIES 25 mm. × 12 mm. × 20 mm. Ferrite cores 4 mm. 472 kc/s operation. Double-tuned 1st and 2nd I.F.s and Single-tuned 3rd I.F. complete with diode and by-pass capacitor.

These ranges are available to manufacturers in versions suitable for most of the popular types of Transistors. The Oscillator coils can be modified to enable specific tuning capacitors to be used provided that bulk quantities are required.

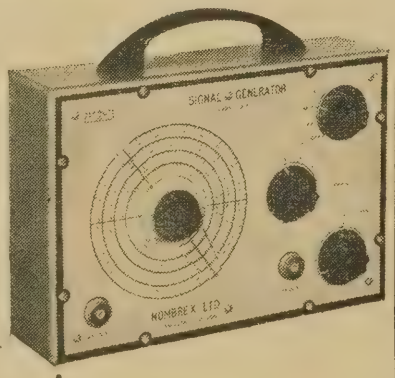
OUR WINDING CAPACITY NOW EXCEEDS 50,000 ITEMS PER WEEK

On the most up-to-date and efficient machines backed by a skilled assembly labour force for all types of coils and assemblies.

Weymouth Radio Manufacturing Co., Ltd., School Street, Weymouth, Dorset

14WW—043 FOR FURTHER DETAILS.

NOMBREX INSTRUMENTATION



Wide-range Transistorised SIGNAL GENERATOR—Model 27.
Range 150 Kc/s. to 350 Mc/s.
★ Accuracy better than 2%.
★ Directly calibrated.
★ Battery operated.
★ Compact and light.

£9.12.3

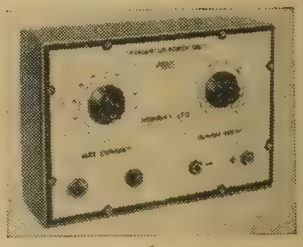
with test lead and battery. Post and packing 3/6 extra.

EXPORT

We invite applications for appointment as distributors or agents in overseas territories, by companies or other organisations with adequate facilities for sales promotion and distribution in the radio and electronics Industry.

We can quote keen c.i.f. export prices on our range of instruments, with reliable deliveries. Write to—

Export Sales Dept., Instruments Division.



Transistor Regulated POWER UNIT—Model 61.
Regulated Output 1-15 Volts.
★ Indispensable for equipment testing.
★ Automatic overload protection.
★ Mains operated—negligible consumption.
★ Eliminates expense of batteries.

£6.10.0

Post and packing 3/6 extra.

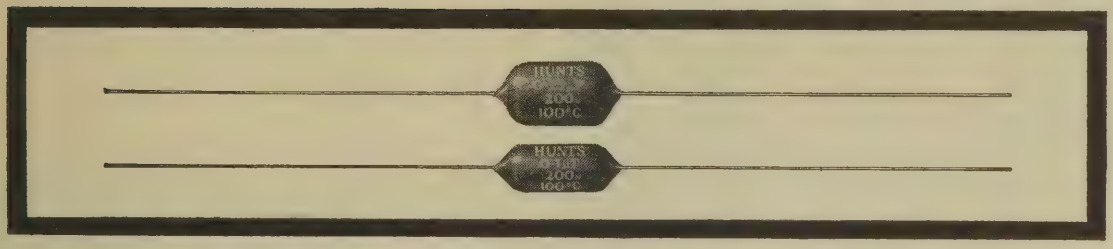
Trade and Export Enquiries Invited **S.A.E. For Full Technical Leaflets**

NOMBREX LTD. **INSTRUMENTS DIVISION** **ESTUARY HOUSE, CAMPERDOWN TERRACE, EXMOUTH, DEVON. PHONE 3515.**

14WW—044 FOR FURTHER DETAILS.

REGISTERED TRADE HUNTS MARK CAPACITORS

another FIRST for HUNTS!



NEW DIPSEAL* W45 range

Hunts new 'Dipseal' process gives designers and service engineers a *new kind* of capacitor—a proven, reliable metallised paper unit in a tough resinous housing. New 'Dipseal' W45 tubulars are as small as or smaller than their thermoplastic cased equivalents; their humidity performance is better; and the hard *thermosetting* resinous housing is unaffected by heat, making soldering safe and easy.
Find out more about the new W45 and other Hunts 'Dipseal' ranges. Full particulars will be sent freely on request.

TYPE W45 STANDARD RANGE		
D.C. Working Voltage	Capacitance Microfarads	Dimensions
200	0.1 to 1	18.5 to 34 x 7.5 to 12mm
400	0.025 to 0.5	$\frac{3}{4}$" to $1\frac{11}{32}$" x $\frac{3}{16}$" to $\frac{1}{2}$"
Temperature Range: −55°C to + 100°C		Capacitance Tolerance ±20% (To order) ± 10%

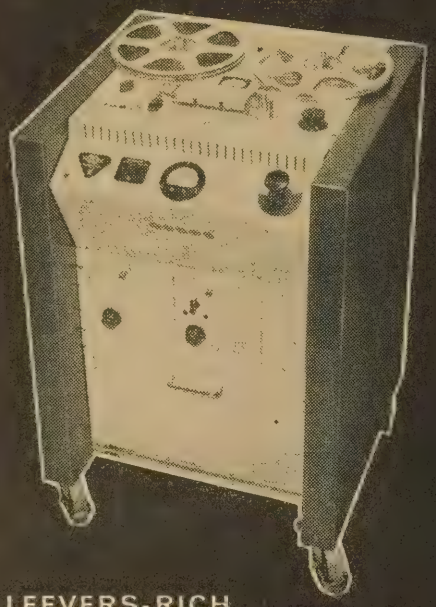
* Better humidity performance than thermoplastic cased units.
* Far cheaper than metal cased units.

HUNTS

A. H. HUNT (Capacitors) LTD.
Wandsworth, London, S.W.18. Tel: VANdyke 6454
Factories also in Surrey and North Wales.

14WW—045 FOR FURTHER DETAILS.

SAVE TIME SPACE COST



LEEVERS-RICH
the studio tape recorder with consistent operation and easy maintenance to save your TIME; compact design and mobility to save your floor SPACE; competitive price and negligible upkeep to lower your COSTS. These down-to-earth practical features AND the impeccable LEEVERS-RICH sound quality.

STANDARD studio recorder console (above) with FULL remote control. Single track from £640.0.0. Just one example from a complete range of portable, console and rack-mounted recorders for single or multi-track use, including the NEW fully automatic version with photo-electric programming system.
DELIVERY—sooner than you expect for this class of equipment! Inquire NOW:—

LEEVERS-RICH

319b Trinity Road London SW18 VANdyke 9054

14WW—046 FOR FURTHER DETAILS.

ORCHARD & IND LIMITED
LOOSE LEAF BINDER DIVISION

Prestige Covers for all purposes, including:

Lightweight binders for—

Brochures
Specifications
Estimates
Bulletins
Catalogues

Many new types and styles of fittings

Heavy Duty Binders for Workshop Manuals, Parts Catalogues, etc.

Write for new Catalogue

Enquiries to:

Head Office,

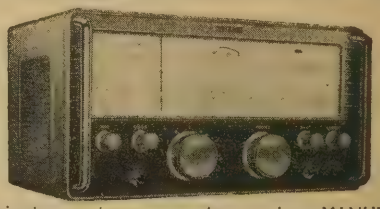
Northgate, GLOUCESTER

Telephone: (OGL2) 22111 (5 lines)

14WW—047 FOR FURTHER DETAILS.

EDDYSTONE COMMUNICATION RECEIVERS

For the professional or Amateur user who likes the Best.



840C
£62

Communication receiver at a moderate price. MANUFACTURING STANDARDS OF THE HIGHEST ORDER, 8 B8A valves Superheterodyne circuit. **FREQUENCY RANGES**

Range 1...	12.4—30 Mc/s.	Range 4...	1.12—2.58 Mc/s.
Range 2...	5.2—12.9 Mc/s.	Range 5...	480—1150 kc/s.
Range 3...	2.5—6.1 Mc/s.		

Ranges 4 and 5 include the International Distress Frequencies. Sensitivity better than 10 microvolts. Selectivity 30 db down at 10 kc/s. off resonance. AC/DC. Internal speaker.

HIRE PURCHASE TERMS

Model No.	Cash Price	Deposit	12 Mthly. Payments	24 Mthly. Payments
870A	£34 8 9	£5 0 0	£2 12 6	—
840C	£62 0 0	£12 0 0	£4 8 3	£2 6 6
940	£125 0 0	£25 0 0	£8 16 6	£4 14 6
EC10	£48 0 0	Transistorised Receiver.		

CONFIDENTIAL TERMS. YOU DEAL SOLELY WITH H.P. RADIO.
Carriage paid per passenger train. SATISFACTION GUARANTEED

HP RADIO

The Eddystone Specialists

SERVICES LTD.

49/51 COUNTY RD., LIVERPOOL, 4

Telephone: AINTREE 1445 ESTAB. 1935

14WW—048 FOR FURTHER DETAILS.

THE CARTRIDGE PROFESSIONALS USE

The BSR C1 ceramic cartridge is unequalled in quality and value. Professionals choose the C1 because of its outstanding performance. You, too can buy this cartridge with a specification comparable to designs costing very much more. The C1 plays 78's and L.P.'s, mono or stereo, it has a stylus pressure of only 2-6 grammes; high compliance of 5.2 x 10^{-6} cm/dyne and channel difference less than 3dB.

BSR C1 CERAMIC cartridge

- Fits all arms with centre hole or standard ½" fixing centre
  Stereo Cartridge with double tipped sapphire stylus
  £2.6.5 inc. tax
- With diamond LP/S tip
  £3.3.10 inc. tax

Please send me full technical specification of the C1 Ceramic Cartridge ☐

Please send me details of the complete range of BSR equipment ☐

Please send me details of my nearest BSR stockist ☐

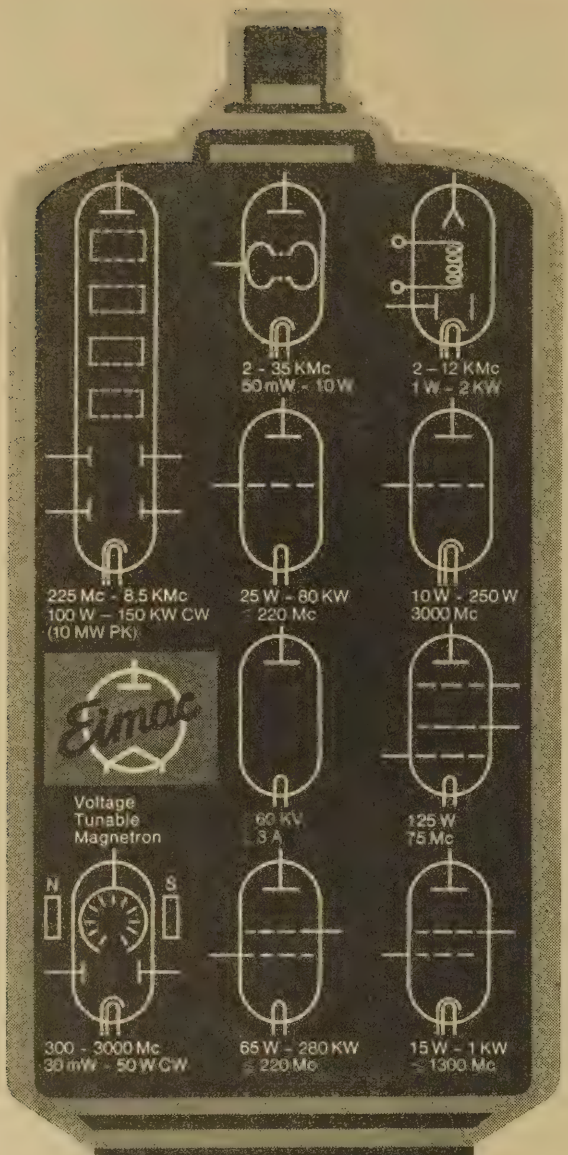
NAME .....

ADDRESS .....

.....

BSR LIMITED, MONARCH WORKS, OLD HILL, STAFFS.

14WW—049 FOR FURTHER DETAILS.



TRANSMITTING AND MICRO-WAVE TUBES

Stocked in Geneva and sold in 59 countries.

30 years experience in manufacturing standard and custom-built quality tubes.

Call on our application engineering service for assistance with your design problems.

Write for new short form catalog.

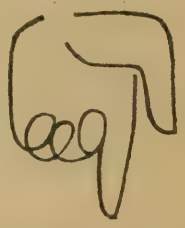
EIMAC

Eitel-McCullough SA, 15, rue du Jeu-de-l'Arc, Geneva, Switzerland, Tel. 358930

ENGLAND: Walmore Electronics, 11-15 Betterton Street, Drury Lane, London W.C. 2. Tel. Temple Bar 0201-5

14WW—030 FOR FURTHER DETAILS.

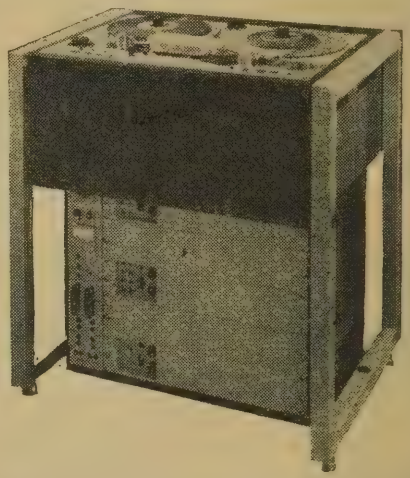
YOUR TAPES ON



PHILIPS PRO 50 RECORDER

These are some of the features that make this new series of recorders particularly suitable for editing—although they are of course completely versatile:

1. Models for 7½/15 i.p.s. or 15/30 i.p.s.
2. One or two tracks on ¼in. tape, 3 or 4 tracks on ½in. tape.
3. CCIR or NARBT tape feed and equalisation.
4. Ferrite heads for long life, maintained quality, precise alignment of multiple gaps, and easy maintenance.
5. Electronic tape tension control.
6. Press-button operation.
7. Finger gaps in headblock for ease of tape handling.
8. Tape lifted during rewind from all heads or in contact with play-back head only if required.
9. Push-button cutting or marking of tape on replay head.
10. Photo-electric tape stop, operating at end of tape or on transparent insert.



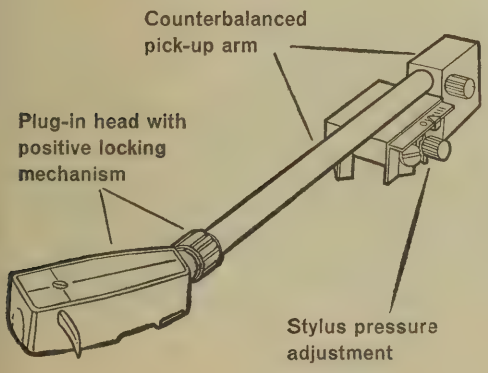
The PRO 50 is one of a new range of Philips Tape Recorders which covers every requirement of high grade professional sound recording: the PRO 20 transportable; the PRO 25 for highest quality studio recording; the PRO 50, particularly suitable for heavy duty operation; and the PRO 70 for multi-channel recording and for dubbing, post-synchronising and transfer.

PETO SCOTT ELECTRICAL INSTRUMENTS LIMITED
SOUND & VISION SYSTEMS

Addlestone Road, Weybridge, Surrey
Telephone Weybridge 45511 Telex 262319
Philips Professional TV and Sound Systems.

14WW—051 FOR FURTHER DETAILS.

If you're looking for professional performance in an automatic turntable, you're looking for the Garrard AT6



The Garrard AT6 is not the cheapest automatic turntable by any means. But in the medium-price range, it offers absolutely unmatched performance. Here are some of the features to think about when you're ready to improve your present system or to build a new one—the AT6 has them all.

- ☐ Dynamically-balanced tubular aluminium pick-up arm which tracks both mono and stereo perfectly—including upside down!
- ☐ Unique stylus pressure adjustment.
- ☐ Plug-in head which accepts most makes of cartridge.
- ☐ Silent, smooth-running Laboratory Series motor, shielded above and below for minimum hum.
- ☐ Large turntable with interchangeable record spindles for automatic or manual operation.
- ☐ Automatic mechanism which provides full intermix facilities.
- ☐ Muting switch and super-sensitive trip mechanism.

See the AT6 in operation at your local dealer and you'll understand its world-wide popularity. Buy it and you'll join the discriminating thousands who have already chosen the leading automatic turntable in its class.

Garrard

Garrard Engineering Ltd.,
Dept. WW.4,
Swindon, Wiltshire

14WW—052 FOR FURTHER DETAILS.

G.30A

FANE HIGH FIDELITY LOUDSPEAKERS

Full Range of Heavy Duty Types for All Purposes

CAST ALUMINIUM CHASSIS. EXTREMELY ROBUST 2in. DIAMETER VOICE COIL ASSEMBLIES

Model	Cone	Frequency response c.p.s.	Impedance ohms	Main resonance c.p.s.	Power handling watts R.M.S.	Flux density gauss	Total flux Maxwells	Voice coil winding	Diam. of Chassis	Baffle Hole	Net weight lbs.	Retail Price
122/10	Single	25-5000	15	32 or 75	20	10,000	100,000	Copper	12in.	11in.	6lbs.	5 gns.
122/10A	Dual	10-15000	15	32 or 75	20	10,000	100,000	Aluminium	12in.	11in.	6lbs.	6 gns.
122/12	Single	25-5000	15	32 or 75	20	12,000	160,000	Copper	12in.	11in.	6lbs.	7 gns.
122/12A	Dual	30-15000	15	32 or 75	20	12,000	160,000	Aluminium	12in.	11in.	6lbs.	8 gns.
122/14	Single	25-5000	15	32 or 75	22	14,000	186,000	Copper	12in.	11in.	7lbs.	9 gns.
122/14A	Dual	30-15000	15	32 or 75	22	14,000	186,000	Aluminium	12in.	11in.	7lbs.	10 gns.
122/17	Single	25-6000	15	32 or 75	25	17,000	226,000	Copper	12in.	11in.	10½lbs.	£11/17/6
122/17A	Dual	30-17000	15	32 or 75	25	17,000	226,000	Aluminium	12in.	11in.	10½lbs.	£12/17/6
152/12	Single	25-3500	15	30 or 75	20	12,000	160,000	Copper	15in.	13¾in.	8lbs.	12 gns.
152/12A	Dual	30-15000	15	30 or 75	20	12,000	160,000	Aluminium	15in.	13¾in.	8lbs.	13 gns.
152/14	Single	25-3500	15	30 or 75	22	14,000	186,000	Copper	15in.	13¾in.	9lbs.	14 gns.
152/14A	Dual	30-15000	15	30 or 75	22	14,000	186,000	Aluminium	15in.	13¾in.	9lbs.	15 gns.
152/17	Single	25-4000	15	30 or 75	25	17,000	226,000	Copper	15in.	13¾in.	12½lbs.	16 gns.
152/17A	Dual	30-17000	15	30 or 75	25	17,000	226,000	Aluminium	15in.	13¾in.	12½lbs.	17 gns.

EXTRA HEAVY DUTY TYPES WITH 3in. DIAMETER POLE PIECES

153	Single	30-3500	15	40 or 75	40	14,000	375,000	Copper	15in.	13¾in.	20lbs.	18 gns.
183	Single	20-3000	15	30 or 75	60	14,000	375,000	Copper	18in.	16¼in.	22lbs.	25 gns.

AVAILABLE THROUGH ALL SOUND EQUIPMENT STOCKISTS

Manufacturers' enquiries to:
FANE ACOUSTICS LTD.
HICK LANE : BATLEY, YORKS.

Sole distributors to Wholesale and Retail Trade:
LINEAR PRODUCTS LTD.
ELECTRON WORKS : ARMLEY, LEEDS

14WW—053 FOR FURTHER DETAILS.

CHASSIS and CASES

by Smith's of EDGWARE ROAD

ELECTRONIC COMPONENT DISTRIBUTORS

287/289 EDGWARE ROAD, LONDON, W.2.
Tel: PADdington 5891/7595

We shall be pleased to quote for all your component requirements

BLANK CHASSIS

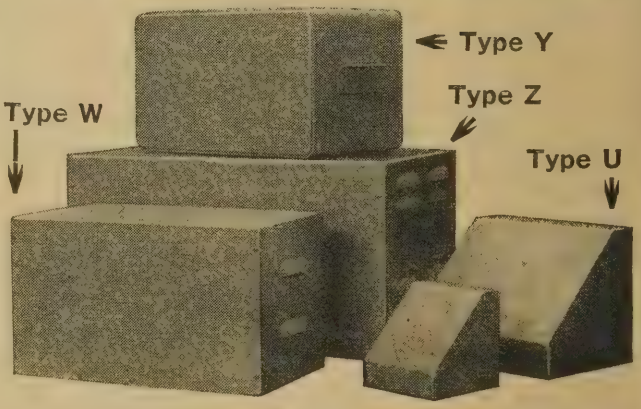
SAME DAY SERVICE

Of over 20 different forms made up to **YOUR SIZE.** Order EXACT SIZE you require to nearest $\frac{1}{16}$th.
(Maximum length 35in., depth 4in.)
Specials dealt with promptly.

SEND FOR ILLUSTRATED LEAFLETS
or order straight away, working out total area of material required and referring to table below which is for four-sided chassis in 18 s.w.g. (for 16 s.w.g. add $\frac{1}{16}$th).

48 sq. in.	4/–	176 sq. in.	8/–	304 sq. in.	12/–
80 sq. in.	5/–	208 sq. in.	9/–	336 sq. in.	13/–
112 sq. in.	6/–	240 sq. in.	10/–	368 sq. in.	14/–
144 sq. in.	7/–	272 sq. in.	11/–	and pro rata.	
P. &. P. 2/6		P. & P. 2/9		P. & P. 3/-	

Discounts for quantities. Finishes arranged for quantities of 25 or over.
FLANGES ($\frac{1}{4}$in., $\frac{3}{8}$in.), 6d. per bend.
STRENGTHENED CORNERS 1/- each corner.
PANELS: Any size up to 3ft. at 4/6 sq. ft. 18 s.w.g.; (16 s.w.g. 5/3). Plus post and packing (over £2 free).



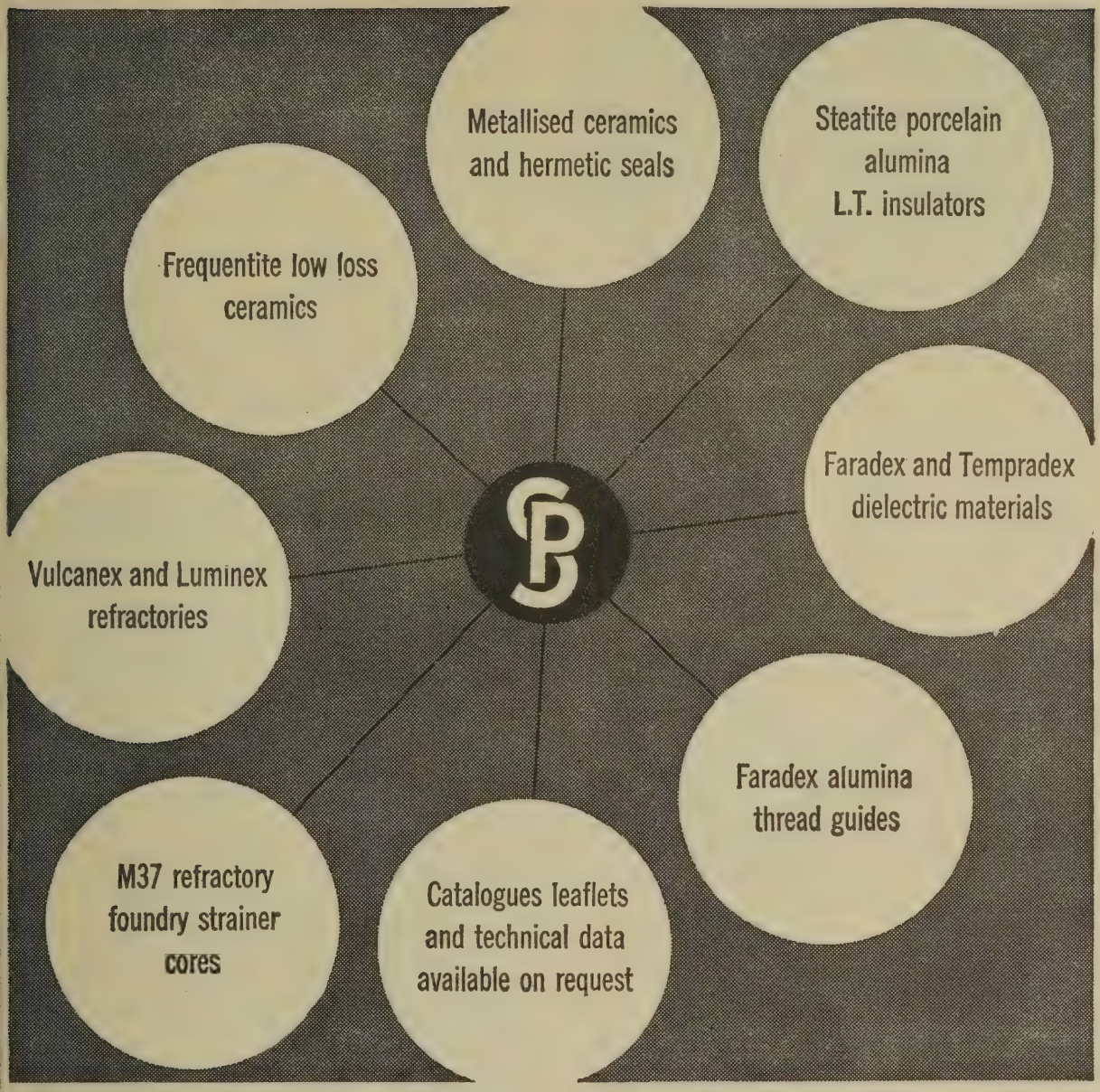
CASES

ALUMINIUM SILVER HAMMERED FINISH

Type	Size	Price	Type	Size	Price
U	4 x 4 x 4*	9/6	Y	8 x 6 x 6*	25/–
U	5½ x 4½ x 4½	14/6	Y	12 x 7 x 7	39/–
U	8 x 6 x 6	20/–	Y	13 x 7 x 9	44/–
U	15 x 9 x 9	42/6	Y	15 x 9 x 7	46/–
W	8 x 6 x 6	19/6	Z	17 x 10 x 9	63/–
W	12 x 7 x 7	32/6	Z	19 x 10 x 8½	67/6
W	15 x 9 x 8	42/–	*Height.		

Plus post and packing (over £2 free).
Type U has removable bottom or back. Type W removable front, Type Y all-screwed construction, Type Z removable back and front.

14WW—054 FOR FURTHER DETAILS.


Metallised ceramics and hermetic seals
Steatite porcelain alumina L.T. insulators
Frequentite low loss ceramics
Faradex and Tempradex dielectric materials
Vulcanex and Luminex refractories
Faradex alumina thread guides
M37 refractory foundry strainer cores
Catalogues leaflets and technical data available on request

FOR ALL RADIO, ELECTRONIC AND DOMESTIC ELECTRICAL CERAMICS CONSULT

STEATITE & PORCELAIN PRODUCTS LTD.

STOURPORT ON SEVERN. WORCS. Telephone: Stourport 2271 Telegrams: Steatain, Stourport

14WW—055 FOR FURTHER DETAILS.

5P110

THE WHARFEDALE Super Range

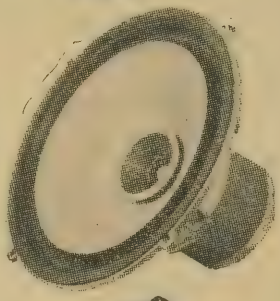
Each loudspeaker in this range is fitted with roll surround for low resonance and double diaphragm assembly for extended HF response.

SUPER 8/RS/DD

Impedance 10/15 ohms
CERAMIC MAGNET
Flux density 14,500 oersteds
Total flux 60,000 maxwells
ALUMINIUM VOICE COIL
Max. input 6 watts rms or 12 watts peak
Frequency range 40-20,000 c/s.
Bass resonance 50/60 c/s.
Price 134/2 inc. P.T.

SUPER 10/RS/DD

Impedance 10/15 ohms
Flux density 16,000 oersteds
Max. input 10 watts rms or 20 watts peak
Frequency range 30-20,000 c/s.
Aluminium voice coil
Bass resonance 38/43 c/s.
Price 218/8 inc. P.T.



SUPER 12/RS/DD

Impedance 12/15 ohms
Flux density 17,000 oersteds
Total flux 190,000 maxwells
Aluminium voice coil
Max. input 20 watts rms or 40 watts peak
Frequency range 25-20,000 c/s.
Bass resonance 26/32 c/s.
Price 350/- (no tax)

Write for informative and fully illustrated 12 page booklet.

Wharfedale

Wharfedale Wireless Works Ltd., Idle, Bradford, Yorks.
Telephone: Idle 1235/6 Telegrams: 'Wharfdel' Bradford.

14WW—056 FOR FURTHER DETAILS.

The most convincing reason for not buying an expensive component bridge—

THE NEW MODEL. 300 FROM K.L.B.

Here's a low price component bridge with features usually found only on more expensive units. This attractive instrument incorporates a ratio range by which transformer ratios and inductance values can be measured against an external standard—particularly useful for production testing. The unit is housed in a tough attractively finished steel case with clearly marked controls for easy operation.

Offering facilities for capacitance measurements in four ranges from 10pf to 100μf, resistance measurements in four ranges from 0.5 ohm to 100 M ohm and also ratio measurements for inductors or for matching other components from .05 : 1 to 20 : 1. An additional feature is a leakage test for capacitors with a polarising voltage adjustable from 0 - 500V D.C.

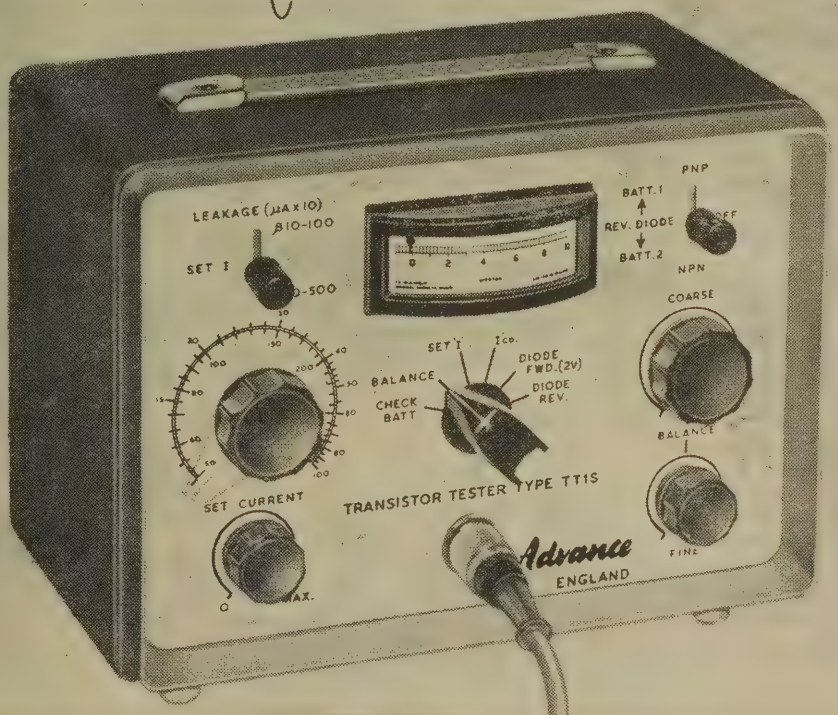
Write today for further details to: Dept. W

KLB electric limited

335 WHITEHORSE ROAD · CROYDON · ENGLAND
Tel: THOrnton Heath 9905

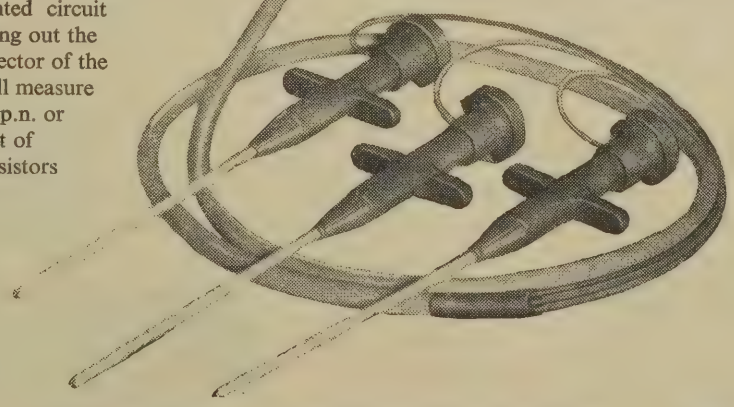
14WW—057 FOR FURTHER DETAILS.

SWITCH TO Advance for in-circuit transistor testing



THE NEW TRANSISTOR TESTER TT1S (CT472)
This portable battery-operated instrument is an invaluable laboratory and servicing tool for engineers working on transistor circuits. A bridge circuit and special clip-on probes allow in-circuit testing, avoiding possibility of damage to components and printed circuit boards. Facilities allow for balancing out the standing currents shunting the collector of the transistor under test. The TT1S will measure in circuit the Beta of transistors (n.p.n. or p.n.p.) in the range 10-500, and out of circuit other characteristics of transistors and diodes. The drum type meter enables measurements to be made quickly and accurately.

Full technical details and specifications are available on request. ● Tests n.p.n. or p.n.p. types ● Measurement of diode characteristics ● Beta range 10-500 ● Leakage current measurements. **NETT PRICE IN U.K. £49.**



Advance

ADVANCE ELECTRONICS LIMITED

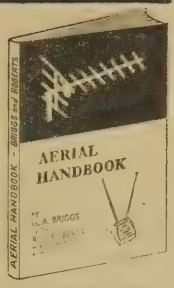
ROEBUCK ROAD, HAINAULT, ILFORD, ESSEX. TELEPHONE: HAINAULT 4444

14WW—058 FOR FURTHER DETAILS.

Another New Book from WHARFEDALE

AERIAL HANDBOOK

by G. A. BRIGGS
with R. S. ROBERTS
M.I.E.R.E. Sen. M.I.E.E.E.
as Technical Editor



PUBLICATION DATE 20th OCTOBER, 1964

144 pp. 115 Illustrations Fine art paper Semi stiff covers

Price only **8/6** (**9/6** *post free*)

With the advent of BBC2 (and other UHF activities in the offing), the importance of the part played by the aerial is on the increase.
The many problems involved are tackled in this book in non-technical terms, but with the backing of R. S. Roberts who is an acknowledged expert on the subject.

Transmitters, Relay Systems, Eurovision, Satellites and the new Post Office Tower also receive attention.

CONTENTS

		Pages
Chapter 1	General Principles	15
2	Medium & Long Waves	7
3	Short Waves	4
4	VHF, Band II	9
5	Television, Bands I & III	9
6	Television, Bands IV & V	12
7	Indoor Aerials	8
8	Diplexers & Multiplexers	5
9	Boosters & Attenuators	9
10	Transmitters	32
11	Relay & Communal Systems	17
12	Activities Abroad	9
	Index	2

Other Books by G. A. Briggs

LOUDSPEAKERS *Fifth Edition* — **PRICE 25/-**
336 pages, 230 illustrations — *(26/3 post free)*

PIANOS, PIANISTS & SONICS — **PRICE 10/6**
190 pages, 102 illustrations — *(11/6 post free)*

STEREO HANDBOOK
Out of Print

A TO Z IN AUDIO — **PRICE 15/6**
224 pages, 160 illustrations — *(16/6 post free)*

AUDIO BIOGRAPHIES — **PRICE 19/6**
344 pages, 64 contributions from pioneers and leaders in audio — *(20/9 post free)*

CABINET HANDBOOK — **PRICE 7/6**
112 pages, 90 illustrations — *(8/6 post free)*

MORE ABOUT LOUDSPEAKERS — **PRICE 8/6**
136 pages, 112 illustrations — *(9/6 post free)*

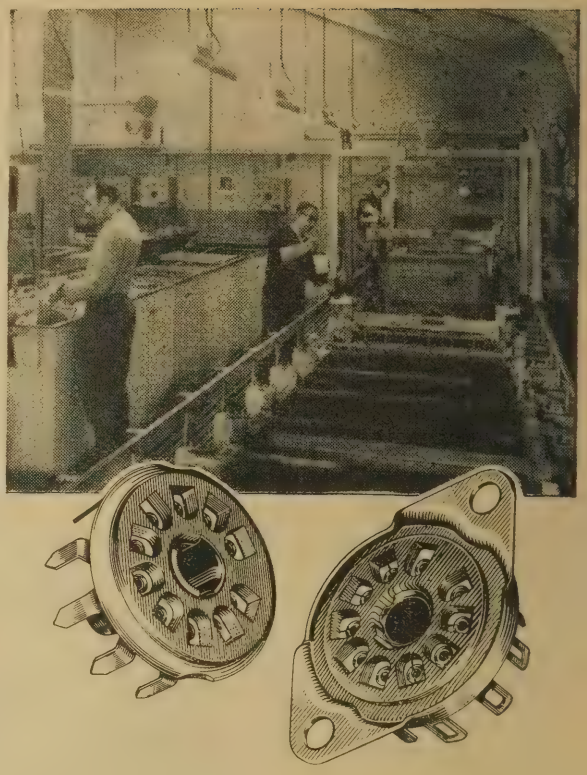
AUDIO AND ACOUSTICS — **PRICE 10/6**
168 pages, 140 illustrations — *(11/6 post free)*

Wharfedale

Sold by Radio Dealers and Book shops or in case of difficulty direct from the Publishers.

WHARFEDALE WIRELESS WORKS LTD.
IDLE · BRADFORD · YORKSHIRE
Telephone Idle 1235/6 *Gram's 'Wharfdel' Bradford*

14WW—062 FOR FURTHER DETAILS.



B10B Valveholders

McMurdo supply special valveholders for the new 10 pin (Decal) based valves type B10B, moulded in polypropylene and phenol formaldehyde. Available for printed circuits or for chassis mounting.

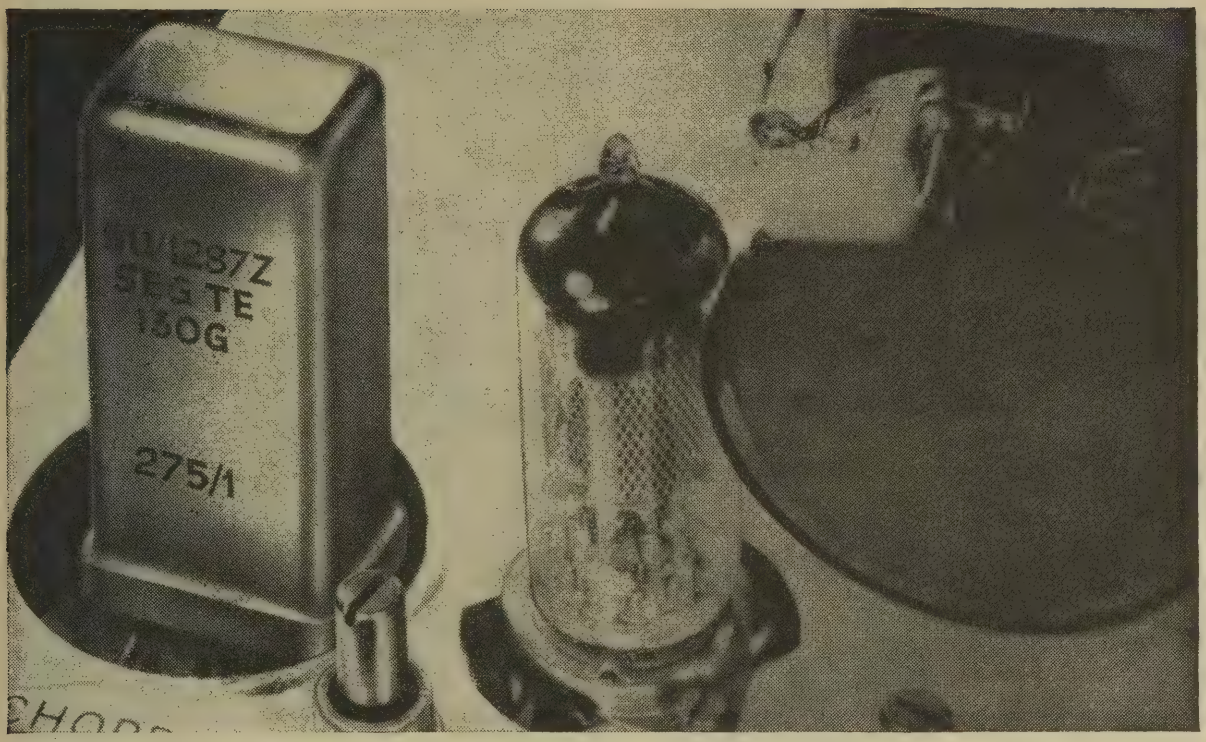
Plating

A general view of plating shop with multi-tank automation line.

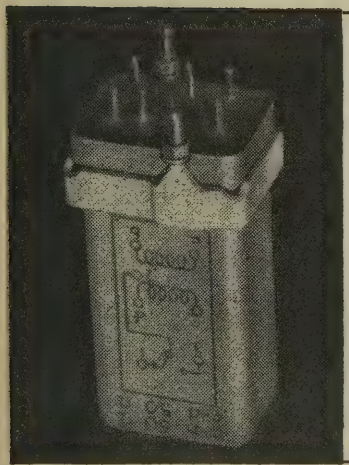
McMurdo

McMurdo Instrument Co. Ltd.
Rodney Rd., Portsmouth, Hants.
Tel. Portsmouth 35555. Telex 8612.
Contact our Sales Office for details of our full range

14WW—063 FOR FURTHER DETAILS.



NOW A RELIABLE LOW CURRENT SWITCHING RELAY TYPE 130



With the relay type 130 you can rely on consistent contact performance at very low voltages and currents. A development of Services Type SM8, this relay uses inorganic materials wherever possible, and an activated carbon 'getter' absorbs any contamination from organic materials. Contact resistance troubles have virtually been eliminated.

Normal life is 10,000 hrs. at 100 ops/sec., *minimum* life 1,000 hrs. Very-high-speed operation — 0.5 msec. (break contact opening) and 1 msec. (make contact closing) is obtained under suitable conditions.

Type 130 has many industrial applications—handling thermocouple outputs, a long-life replacement for Services type SM8, or a d.c. 'chopper' as in the Marconi Instruments Ltd. bridge shown above. Ministry of Aviation approved.

NATO Stock Nos. 5945-99-012-8197, 8198, 8199, 8200, 8201.

AEI

Associated Electrical Industries Limited

TELEPHONE APPARATUS DEPARTMENT

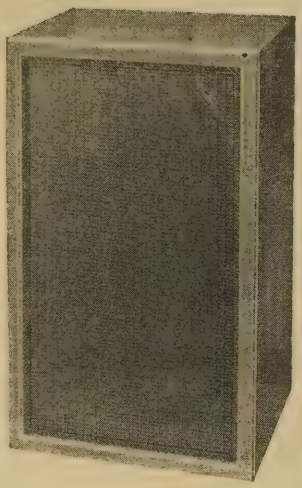
Telecommunications Division Woolwich London SE18 Woolwich 2020 Ext. 621

TA 1031

14WW—061 FOR FURTHER DETAILS.

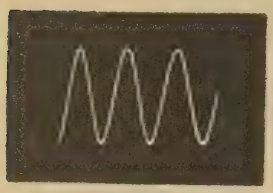
MINIMUM SPACE
FOR CLEAN CLEAR
BASS

WHARFEDALE
W2



A really compact loudspeaker system giving full range performance on mono and stereo. **£29/10/-,** fully finished with a choice of polished walnut or mahogany veneers, or oiled teak. Oak finish available to special order.
£28/10/- unpolished.

SIZE: 23½" × 14" × 12"
WEIGHT: 37 lb. complete
FREQUENCY RANGE: 30/17,000 c/s
MAX. POWER: 15 watts
IMPEDANCE: 15 ohms



As the waveform shows, the enclosure gives distortion-free performance down to 30 c/s with 4 watts input.

FREE LEAFLET ON CABINET MODELS ON REQUEST

Wharfedale

Wharfedale Wireless Works Ltd., Idle, Bradford, Yorkshire.
Tel: Idle 1235/6. Telegrams: 'Wharfdel,' Bradford.

14WW—059 FOR FURTHER DETAILS.

NOW—THESE WORLD-FAMOUS RELAYS MADE AND DISTRIBUTED IN BRITAIN BY AMF

RS RELAY. A low-cost sensitive relay designed for use in applications where a very small, light-weight relay is required with sensitivities of 60 milliwatts or less.

KHP RELAY. Rugged 4PDT miniature plug-in relay AC or DC operation, contacts rated at 3 amps. Physical size 1 ¼" x 1 ¼". Mechanical life 100 million operations. Used in data processing computers, process control.

Potter and Brumfield relays are distributed in Southern England by Automatic Controls and Components Ltd., Bridge Chambers, Bridge Street, Leatherhead, Surrey. Or we would be glad to hear from you direct. For all information, just get in touch with

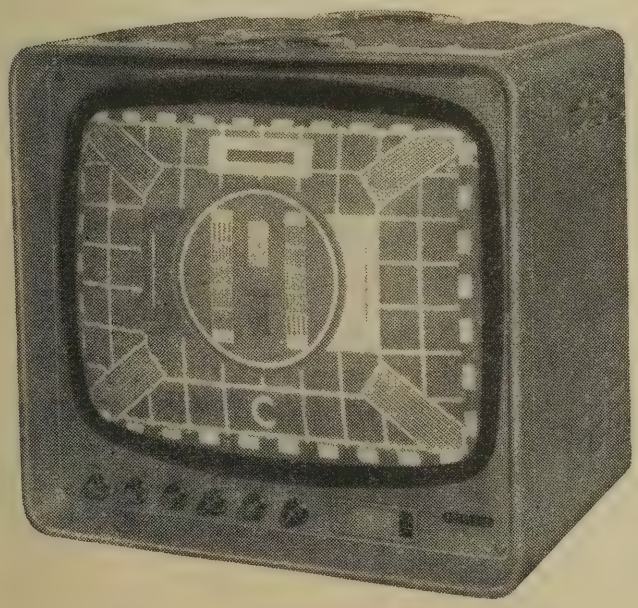
AMF INTERNATIONAL LTD.
ELECTRICAL PRODUCTS DIVISION
WHITSTABLE, KENT. TELEPHONE 3901
A member of the International Organisation of American Machine and Foundry Company.

14WW—060 FOR FURTHER DETAILS.

Thorn Television Monitoring Equipment

O.B. MONITORING TELEVISION RECEIVER TYPE WJ.11

This portable weatherproof receiver provides standard level video and audio outputs suitable for feeding video monitors and associated audio equipment. No picture tube is incorporated, but a built-in loudspeaker enables the television sound channel to be monitored. The receiver is designed to accept signals in Bands I and III on the 405 line system and in Bands IV and V on the 625 line system.
Features include black level AGC and the provision of automatic frequency control on the UHF bands.
A rack mounting version, type WJ.12 is also available.



TELEVISION PICTURE MONITORS
19″—Type VM606 23″—Type VM608

These Thorn monitors are intended for general purpose studio applications. They incorporate a 110° picture tube with bonded face plate thus ensuring minimal physical size and avoiding the need for a separate implosion guard.
Automatic or manual 405/525/625 line standard selection is provided, together with remote control of brightness and contrast. Remote selection of two alternative video inputs is also available.
The monitors feature high picture brightness with stabilised E.H.T. and 8 Mc/s video bandwidth. Picture centering controls are on the front panel. Single standard and non-automatic 3-standard models are also available.

Thorn Electronics Limited

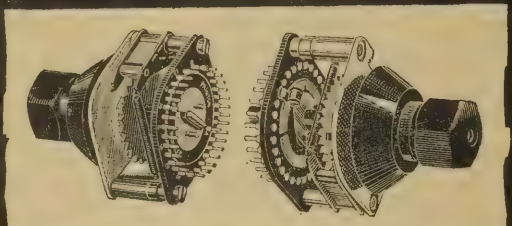
THORN ELECTRONICS LIMITED Wellington Crescent, New Malden, Surrey. (MALden 8701).

A MEMBER OF THE THORN ELECTRICAL INDUSTRIES GROUP OF COMPANIES

TE67

14WW—064 **FOR FURTHER DETAILS.**

ROTARY SWITCH WITH 96 STANDARD VERSIONS



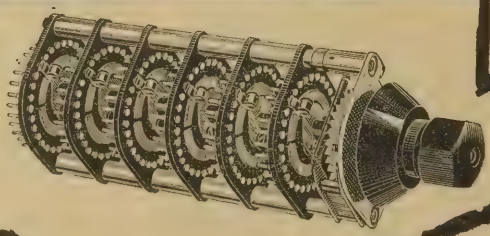
UP TO 30 POSITIONS

UP TO 6 BANKS

EACH BANK 1, 2, 3, 4 OR 6 POLE

BREAK BEFORE MAKE
OR MAKE BEFORE BREAK

SILVER OR GOLD PLATED
CONTACTS



ALL ADDING UP TO

PAINTON RELIABILITY

PAINTON

Send for leaflet S.S.1

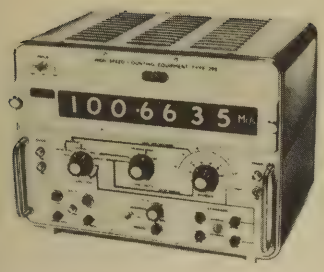
Painton
& CO LIMITED
KINGSTHORPE · NORTHAMPTON
Tel: 34251 (10 lines) · Grams: 'Ceil' Northampton · Telex 31576

Australia Painton (Australia) Pty. Ltd. · Benelux Painton S.A. · Germany Deutsche Painton G.m.b.H. · Italy Painton Italiana S.p.A. · Sweden Svenska Painton A.B. · U.S.A. Painton Inc.

14WW—065 FOR FURTHER DETAILS.

Airmec

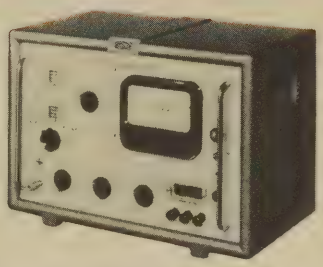
Electronic Laboratory Instruments



High Speed Counter 298

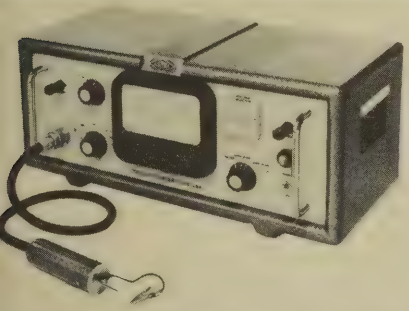
Frequency Range : 0–100 Mc/s direct
Time Range : 1μsec–10^8sec
Single or two line operation
Transistorised—compact 12 figure display
Oscillator Stability 5 parts in 10^8

The accuracy and reliability of the advanced precision instruments shown on these pages is the outcome of many years' experience of design and manufacture in this specialised field.



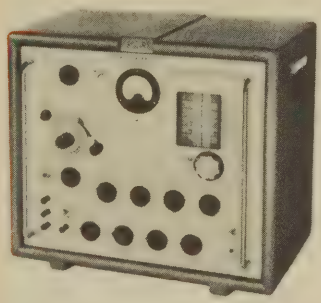
Modulation Meter 210

Frequency Range : 2.25 to 600Mc/s
Input Level : 5mV to 10V
A.M. Range : 0 to 100%
F.M. Range : 0 to ±100kc/s in 4 ranges
Accuracy : A.M. ±3%; F.M. ±5%



Millivoltmeter 264

Measuring Range : 300μV–100V in eight ranges
Frequency Range : 20c/s–10Mc/s
Low Input Impedance (using input socket) : 75 ohms
Probe Input
Impedance : 4.7MΩ and 14.5pF



V.H.F. Signal Generator 204

Frequency Range : 1–320Mc/s in 5 ranges
Stabilised
Outputs : 2μV–220mV RMS from 52 or 75 ohms
Attenuators : 0–80dB in 20 dB steps
0–20dB in 2dB steps
0–2dB continuously variable

Frequency Standard Type 311

Stability : 5 parts in 10^9
Crystal : 1Mc/s in oven
Outputs : Pulse 1c/s–1Mc/s in decade steps
Sinewave 100c/s–1Mc/s in decade steps. All simultaneously
Comparison Circuits : Oscilloscope for lissajous figures or beam modulated traces. Beat Detector for aural detection. Edge Scale Meter for sub-audio beats

Send for details of Airmec Electronic Laboratory Instruments

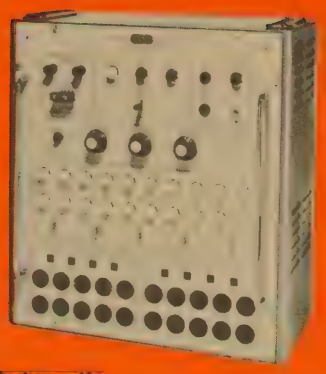
For details of the instruments shown and others in the Airmec range, complete (over), detach and return the attached pre-paid card.

Postage will be paid by Licensee

No Postage Stamp necessary if posted in Great Britain or Northern Ireland

BUSINESS REPLY CARD
Licence No. KE 1599

AIRMEC LIMITED
HIGH WYCOMBE
BUCKINGHAMSHIRE



Automatic Continuity Tester 859

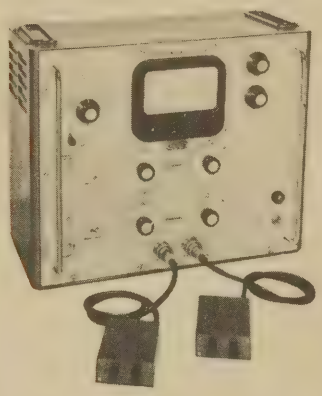
Tolerance: 5, 10 and 20%
Circuits: Up to 100 parts of a circuit may be tested with respect to four points
Alarm: Tester stops and indicates line on which fault exists
Speed: 3 tests per second to 1 every 2 seconds

5 kV Ionisation Tester 732

Test Voltage: Continuously variable from 250–5000V, non-destructive and non-lethal
Ionisation Indication: Audible (loudspeaker) visual (meter) or external

H.F. Wave Analyser 853

Frequency Range: 30kc/s to 30Mc/s in 7 bands
Signal Input Range: 1μV–4V
Accuracy: HF Attenuator ±0.2dB
LF Coarse „ ±0.1dB
LF Fine „ ±0.2dB



L.F. Phase Meter 206

Frequency Range: 20c/s to 100kc/s
Input level: 1mV to 1V
Display: Direct reading on 6″ meter, with 4 alternative scales
Input Impedance: 12M ohms

Display Oscilloscope 279

Bandwith: D.C. to 10kc/s (Y amplifier), D.C. to 8kc/s (X amplifier)
Sensitivity: (Y) greater than 10cm/volt; (X) greater than 8cm/volt
17 inch tube
Beam switch gives 1, 2 or 4 traces

Please tick as appropriate

- ☐ Please forward a copy of the complete Airmec Catalogue with price list.
- ☐ Please forward a copy of your Short Form Catalogue.
- ☐ I should like to visit your works to see your range of equipment.
- ☐ Please send me details of your type No. . . . . .
- ☐ Please ask your technical representative to telephone for an appointment to discuss/demonstrate equipment.

Name _____
Position _____
Company _____
Address _____
_____
Telephone No. _____

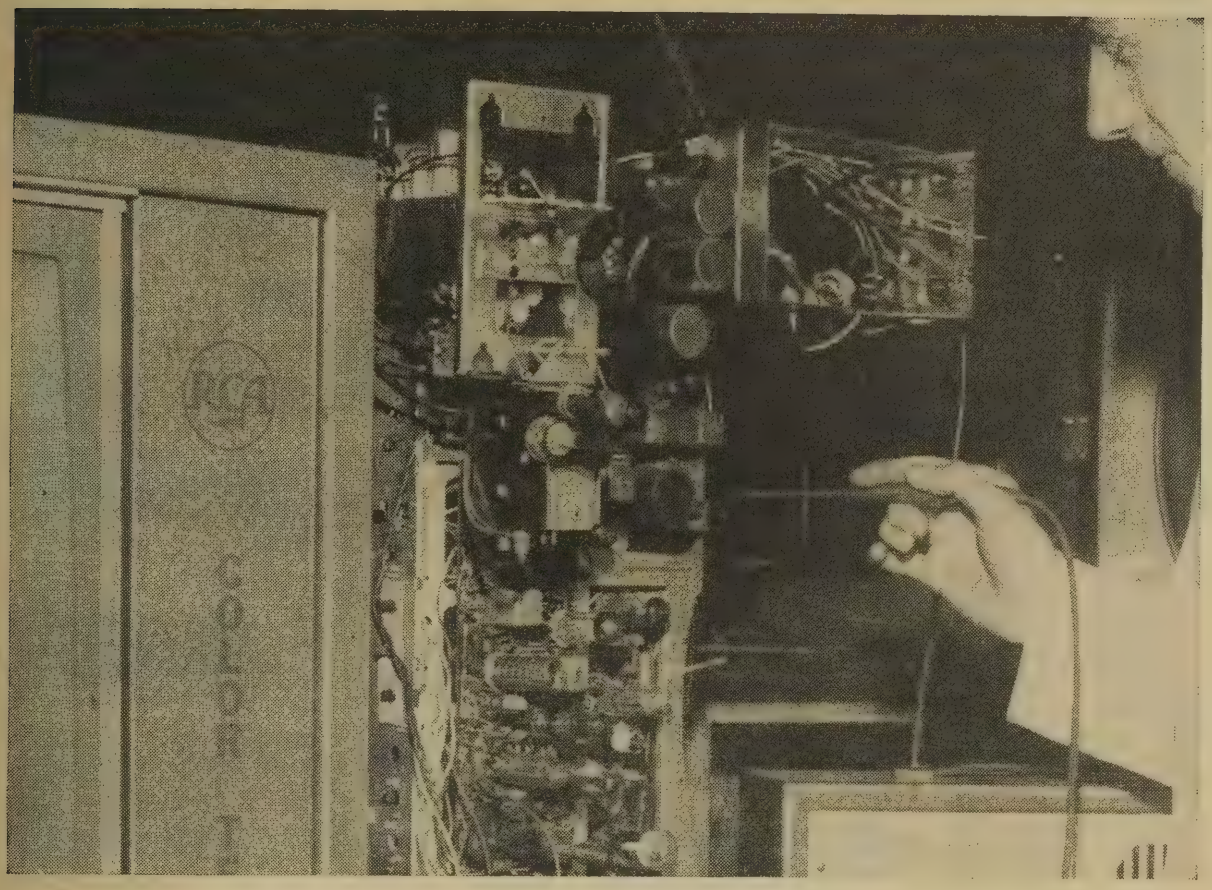
BLOCK CAPITALS PLEASE

Airmec

for peak performance consistently

LABORATORY INSTRUMENTS DIVISION
HIGH WYCOMBE
BUCKINGHAMSHIRE ENGLAND
TEL: HIGH WYCOMBE 21201 (10 LINES)
CABLES: AIRMEC HIGH WYCOMBE

IS TELEVISION YOUR BUSINESS?



RCA offer you a unique chance to learn about colour television

Colour television is just around the corner. Over the next decade or so it will come to represent the main source of income to all in the television business. For those engineers and technicians who can work with colour equipment this decade is going to be an opportunity paralleled only by the coming of monochrome television. Do you yet know enough about colour television to take this great opportunity when it comes?

Here is a unique chance to learn about colour television. From RCA, who have more experience of colour television than any other company in the world, comes a concise, comprehensive, four volume home study course. The first such course available in Britain. Direct from the RCA Institute in New York, this course covers every aspect of colour television, both theory and practice

If you would like to know more about RCA's home-study courses in colour television please complete this coupon and post it to the address below.

NAME .....

ADDRESS .....

.....

RCA GREAT BRITAIN LIMITED

A subsidiary of Radio Corporation of America

RCA VICTOR DIVISION, LINCOLN WAY, WINDMILL ROAD, SUNBURY-ON-THAMES, MIDDX. SUNBURY-ON-THAMES 5511

14WW—067 FOR FURTHER DETAILS.

You'll like the sound of the NEW 668

it's built for booms

New from Electro-Voice, USA: dynamic cardioid model 668, one of the first microphones designed specially for boom use. Not an improvisation; a specific.
It has a moving coil element, Acoustalloy diaphragm; a versatile filter unit, built direct into the slender body; wide range 'flat' position; variable treble and bass response; instantly adjustable and foolproof; wind shield and shock isolating mount are standard equipment.

FULL DETAILS ARE AVAILABLE FROM KEF

KEF

KEF ELECTRONICS LTD · TOVIL · MAIDSTONE · KENT · ENGLAND
TELEPHONE: MAIDSTONE 55761. GRAMS: KEF MAIDSTONE
Sole distributors of Electro-Voice equipment in the U.K.

Electro-Voice

14WW—065 FOR FURTHER DETAILS.

FREE TO AMBITIOUS ENGINEERS
— THE LATEST EDITION OF ENGINEERING OPPORTUNITIES

Have you sent for your copy?

ENGINEERING OPPORTUNITIES is a highly informative 156-page guide to the best paid engineering posts. It tells you how you can quickly prepare at home for a recognised engineering qualification and outlines a wonderful range of modern Home Study Courses in all branches of Engineering. This unique book also gives full details of the Practical Radio & Electronics Courses, administered by our Specialist Electronics Training Division—the *B.I.E.T. School of Electronics*, explains the benefits of our Employment Dept. and shows you how to qualify for five years promotion in one year.

We definitely Guarantee

"NO PASS—NO FEE"

Whatever your age or experience, you cannot afford to miss reading this famous book. If you are earning less than £25. a week, send for your copy of "ENGINEERING OPPORTUNITIES" today—FREE.

WHICH IS YOUR PET SUBJECT?

Mechanical Eng., Electrical Eng., Civil Engineering, Radio Engineering, Automobile Eng., Aeronautical Eng., Production Eng., Building, Plastics, Draughtsmanship, Television, etc.

GET SOME LETTERS AFTER YOUR NAME!

A.M.I.Mech.E.
A.M.I.C.E.
A.M.I.Prod.E.
A.M.I.M.I.
A.I.O.B.
B.Sc.
A.M.I.E.R.E.
City & Guilds
Gen. Cert. of Education
Etc., etc.

PRACTICAL EQUIPMENT

Basic Practical and Theoretic Courses for beginners in Radio, T.V., Electronics, Etc., A.M.I.E.R.E. City & Guilds 'Radio Amateurs' Exam. R.T.E.B. Certificate P.M.G. Certificate Practical Radio Radio & Television Servicing Practical Electronics Electronics Engineering Automation

INCLUDING TOOLS!

The specialist Electronics Division of B.I.E.T. NOW offers you a real laboratory training at home with practical equipment. Ask for details.

B.I.E.T. SCHOOL OF ELECTRONICS

POST COUPON NOW!

Please send me your FREE 156-page "ENGINEERING OPPORTUNITIES"
(Write if you prefer not to cut page)

NAME.....

ADDRESS.....

.....

.....

SUBJECT OR EXAM THAT INTERESTS ME .....

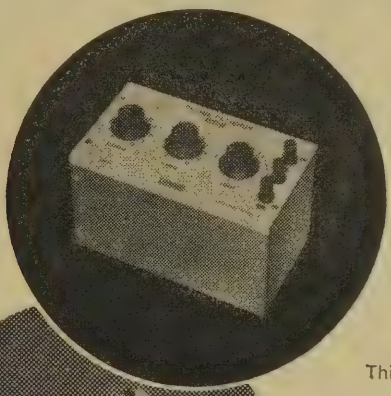
BRITISH INSTITUTE OF ENGINEERING TECHNOLOGY
(Dept. SE/22), 29 Wright's Lane, London, W.8

THE B.I.E.T. IS THE LEADING ORGANISATION OF ITS KIND IN THE WORLD

14WW—069 FOR FURTHER DETAILS.

CAPACITOR & RESISTOR DECADE UNITS

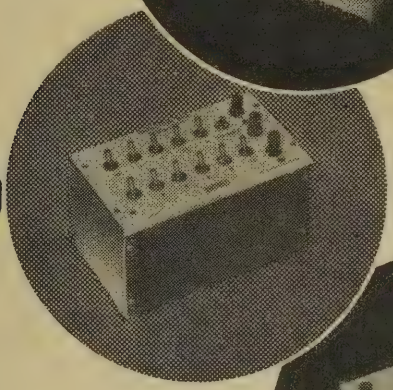
These units are sturdy and inexpensive instruments suitable for both industrial and academic use. High grade industrial components are used throughout the construction and the cases are made up from standard components of the Lektrokit Chassis Construction System



£8-10-0

LKU-111 DECADE CAPACITOR

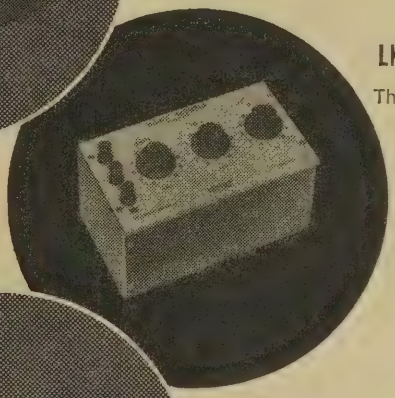
The Decade Capacitor covers the range 50 pF to 0.111 uF with an accuracy of 5%. The unit consists of a variable air-spaced capacitor covering 50-1000 pF in parallel with two switched decades



£13-0-0

LKU-121 CAPACITOR BOX

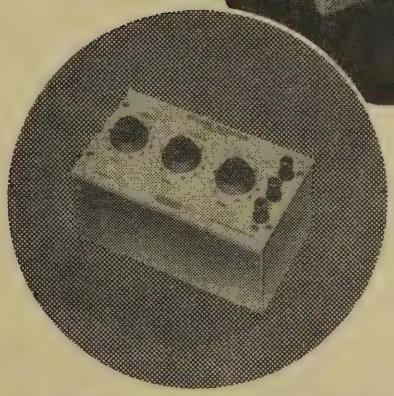
This unit covers the range 0.05 to 28 uF in steps of 0.05 uF, each capacitor being separately switched. An additional switch is provided enabling the total capacitance of the box to be switched in or out of circuit in one operation



£13-0-0

LKU-211 DECADE RESISTOR

This unit covers the range 0 to 1.11 kΩ in steps of 1Ω with an accuracy of ±2% the resistance elements being heavy-duty wirewound resistors made from low temperature coefficient wire



£13-0-0

LKU-221 DECADE RESISTOR

This unit, which covers the range 0 to 1.11 M in steps of 1 k with an accuracy of 0.5% is very similar in construction to the LKU-211. The two units together form a convenient and inexpensive 6-decade resistor

ALL THESE UNITS ARE AVAILABLE FROM STOCK

A·P·T ELECTRONIC INDUSTRIES LIMITED

CHERTSEY ROAD, BYFLEET, SURREY

Phone: BYFLEET 411311/2/3/4 PABX Grams: APTRAN BYFLEET

Please send me your leaflet on:

☐ **DECADE RESISTORS**
☐ **CAPACITOR BOXES**

NAME .....

ADDRESS .....

..... WW11

14WW—070 FOR FURTHER DETAILS.

EXCEL in ELECTRONICS

Through this ICS 3-way Training Method:

1 MASTER THE THEORETICAL SIDE

From basic principles to advanced applications, you'll learn the theory of electronic engineering, quickly and easily through ICS. That's because each course is set out in easy-to-understand terms.

2 MASTER THE PRACTICAL SIDE

ICS show you how to develop your practical abilities in electronic engineering—*alongside* your theoretical studies. It's the only sure way to success. All training manuals are packed with easy-to-follow illustrations.

3 MASTER THE MATHEMATICAL SIDE

To many this aspect is a bitter problem. Even more so because no electronic engineer is complete without a sound working knowledge of maths. But new ICS teaching makes mathematics easier to learn.

Wide range of courses available including:
Radio/T.V. Engineering and Servicing, Colour Television, Electronics, Electronic Maintenance, Instrumentation and Servomechanisms, Telemetry, Computers, etc.
NEW! Programmed Course on Electronic Fundamentals.

EXPERT COACHING FOR:
INSTITUTION OF ELECTRONIC & RADIO ENGINEERS
CITY & GUILDS TELECOMMUNICATION TECHNICIANS
CITY & GUILDS SUPPLEMENTARY STUDIES
R.T.E.B. RADIO/T.V. SERVICING CERTIFICATE
RADIO AMATEURS' EXAMINATION
P.M.G. CERTIFICATES IN RADIOTELEGRAPHY

And there are practical "learn as you build" radio courses as well.

Member of the Association of British Correspondence Colleges.

FOR **FREE** HANDBOOK POST THIS COUPON TODAY
I.C.S., Dept. 227, INTERTEXT HOUSE,
PARKGATE ROAD, LONDON, S.W.11

NAME .....
ADDRESS .....
.....
OCCUPATION..... AGE..... 11.64

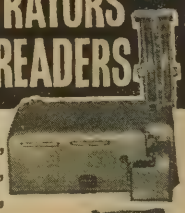
INTERNATIONAL CORRESPONDENCE SCHOOLS

14WW—071 FOR FURTHER DETAILS.

TELEPRINTERS·PERFORATORS REPERFORATORS·TAPEREADERS

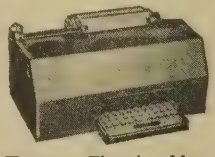
Codes: Int. No.2; Ferranti/Pegasus, Elliott 803 etc.

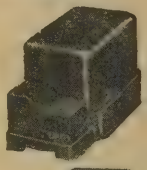
2 AND 5 WIRE, F.S.K. TERMINALS, POWER SAMAS, FLEXO WRITER AND BURROUGHS EQUIPMENT

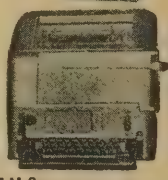


TELEGRAPH AUTOMATION AND COMPUTER ACCESSORIES

Picture Telegraph Equipment, Desk-Fax, Morse Equipment, Cold Cathode Matrics, Stroboscope and Electronic Forks, Pen Recorders, Switchboards, Rectifiers, Tape Pullers and Rewinders, Governed, Synchronous and Phonic Motors, Suppressors, Teleprinter and Teletype Tables, Silence Covers, Terminals, V.F. and F.M. Equipment, Telephone Carriers and Repeaters, Multiplex Transmitters, Triple Stabilised Power Units, Send/Receive Low and High Pass Filters, Teleprinter and Relay Testers, Oscilloscopes, Valve Testers, Electric Meters, Teleprinter and Teledeltos Paper, Plugs, Sockets, Key, Push, Miniature and other Switches, Cord Wires and Cables, Relays and Relay Bases, Uniselectors, Telephone, Decimal and other Counters, Telegraph and Mains Transformers, Racks and Consoles, Miscellaneous Accessories.



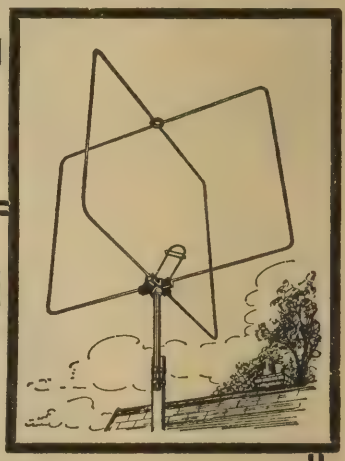




BATEY & COMPANY
Gaiety Works, Akeman Street, Tring, Herts.
Tel.: Tring 3476 (3 Lines) Cables: RAHNO TRING

14WW—072 FOR FURTHER DETAILS.

NOW re-designed and fully weather protected



The
MINIMITTER BIRDCAGE F.M. AERIAL
Mk. 2

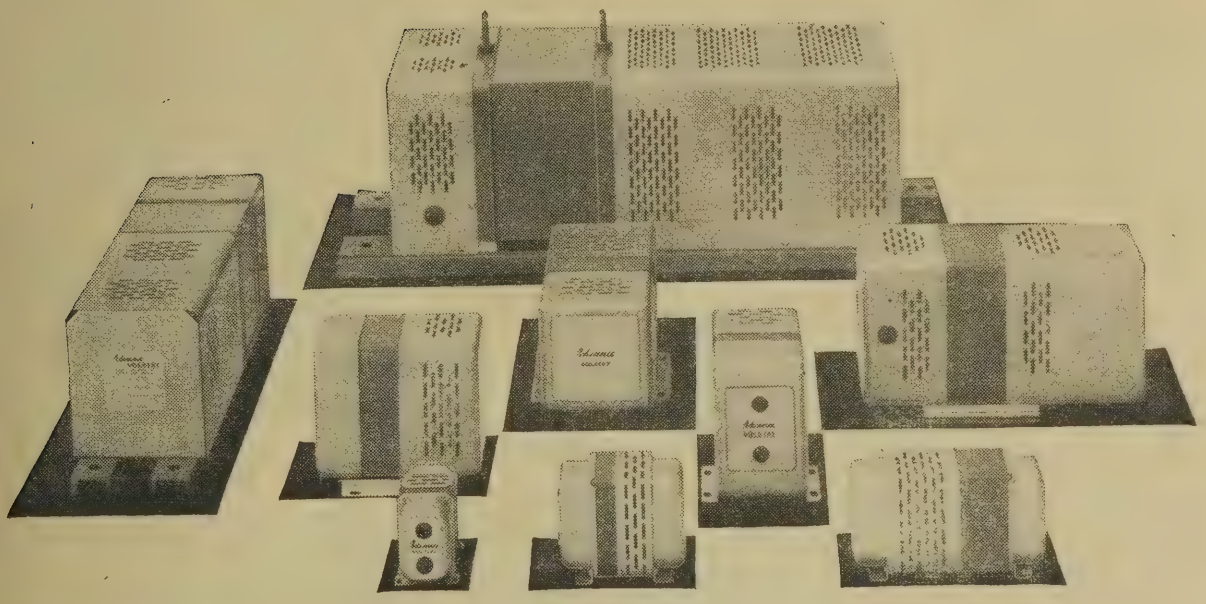
- Suitable for 88-108 Mc/s.
- High Gain (+9.5dB) with high Front to Back (−35dB) and Front to Side (−30dB) ratios.
- Full wavelength elements reduce interference.
- Elimination of vertically polarised signals gives freedom from aeroplane "flutter."
- Tuning facility incorporated to enable the cable to be accurately matched to the aerial.
- Suitable for loft or outside erection.

Retail price **£5** (+ 4/6 post & packing)
TRADE ENQUIRIES INVITED

Order direct from
MINIMITTER (1964) LTD. Albion Mews, Kilburn
High Road, London, N.W.6 (MAlda Vale 5588)
Manufacturers of Specialist Aerials and Aerial Equipment for the Entertainment and Communication Industries.

14WW—073 FOR FURTHER DETAILS.

SWITCH TO Advance and forget fluctuating voltage



CONSTANT VOLTAGE TRANSFORMERS

There are VOLSTAT Constant Voltage Transformers from 15W to 10kW rating (and others to special design) to keep your equipment operating in the factory or in the field no matter how the voltage supply is fluctuating. Stabilisation to ± 1% is continuous and automatic from no load to full load, for supply variations of ± 15%. VOLSTATS are used throughout the world in a variety of equipments such as:

Measuring Instruments, Hospital Equipment, Control and Computing Installations, Photographic and Photometric Devices.

VOLSTAT types CVN and CVS have all the advantages of the CVT range with, in addition, reduced harmonic distortion limited to less than 5%.

If fluctuating voltage affects your production or your products a VOLSTAT is the answer. *For further technical details please write to*

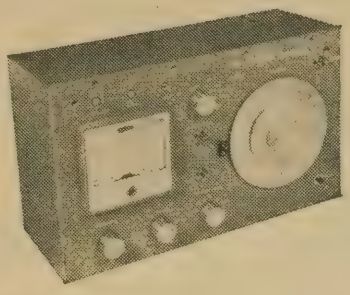
Advance

AV/2A

ADVANCE ELECTRONICS LIMITED

ROEBUCK ROAD, HAINAULT, ILFORD, ESSEX. TELEPHONE: HAINAULT 4444

14WW—074 FOR FURTHER DETAILS.



Measurement of Harmonic Distortion

One of the most essential measurements necessary in a high quality audio system is that of simple harmonic distortion. It is impossible to do serious development work on anything in high quality audio without measurement of this fundamental parameter.

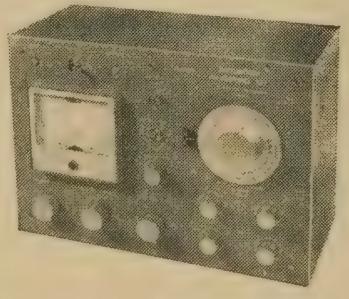
RADFORD make the most advanced audio equipment in the world, and in order to do this it was found necessary to develop measuring instruments of a superior performance than those existing. The Low Distortion Oscillator and Distortion Measuring Set were designed by audio engineers knowing the requirements of such apparatus in audio engineering.

The Low Distortion Oscillator generates sine waves of extreme purity from 5 c/s to 250 Kc/s. The instrument also contains a valve millivoltmeter, a squareing circuit which will produce a clean 250 Kc/s square wave, and a switched 'T' 110 dB 600 ohm attenuator with facilities for continuous interpolation. The distortion of the oscillator is less than 0.005% at mid-band frequencies from its 600 ohm output attenuator. It is also capable of a very low distortion output of about 0.001% or below from the 10K ohm output position at mid-band frequencies.

The Distortion Measuring Set is a complementary equipment, and is capable of measuring extremely low distortion content. The most sensitive range on the instrument is 0.01% f.s.d. On this range it is possible to get an accurate measurement of 0.002% distortion and an indication of the order of 0.001% distortion.

The design of these instruments is described in leaflets which are available upon request.

Prices: Low Distortion Oscillator. **£95.**
Distortion Measuring Set. **£75.**



RADFORD ELECTRONICS LTD.

Ashton Vale Estate, Bristol, 3. Tel. 662301/2

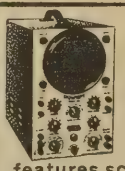
14WW—075 FOR FURTHER DETAILS.

WORLD FAMOUS EICO TEST EQUIPMENT PROVIDES A LIFETIME OF ACCURATE, DEPENDABLE SERVICE WORK—KITS & WIRED

Model #1020 — Power & Bias Supply For Transistorized radios, hearing aids, "walkie-talkie" transistor receivers, preamps and tuners, language laboratory transistor amplifiers and test equipment.

Model #955—In-Circuit Bridge-Type Capacitor Tester. Provides extraordinary sensitive short and open tests and includes a Wien Bridge for capacity measurements.

Model #1140 —Series/Parallel R-C Combination Box, is an extremely valuable instrument for TV, radio and audio servicing as well as general laboratory work and experimentation.



Model #460 — DC-Wide Band 5" Oscilloscope The World's Finest professional scope — far outperforms and outfeatures scopes of many times its cost! For Colour, Black & White TV, Laboratory & Industry.

Model #232 — PEAK-TO-PEAK VTVM. Complete with exclusive Uni-Probe, registered U.S. Patent Office. This unit performs all functions — selects DC or AC—OHMS! A leader in professional peak-to-peak VTVM'S.

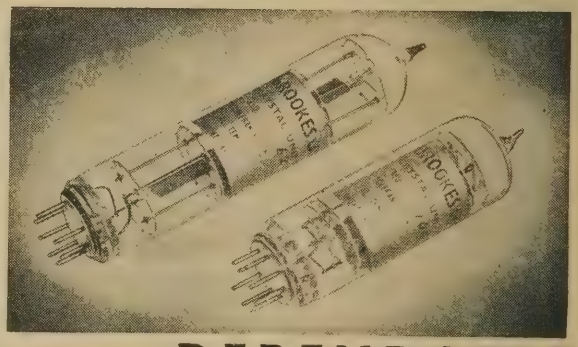
All EICO products are designed and engineered by professionals

Distributor for United Kingdom: **Direct T.V. Replacement Ltd.**
126, Hamilton Road, West Norwood, London S.E. 27, England

Factory Export Department **ROBURN AGENCIES, INC.**
431 Greenwich St., New York, N.Y. 10013, U.S.A.

14WW—076 FOR FURTHER DETAILS.

BROOKES *Crystals*



mean DEPENDABLE frequency control

● *Illustrated above are*
Left:
Type G.2 Crystal Unit. Frequency 62 k/cs.
Right:
Type G.1 Crystal Unit. Frequency 100 k/cs.

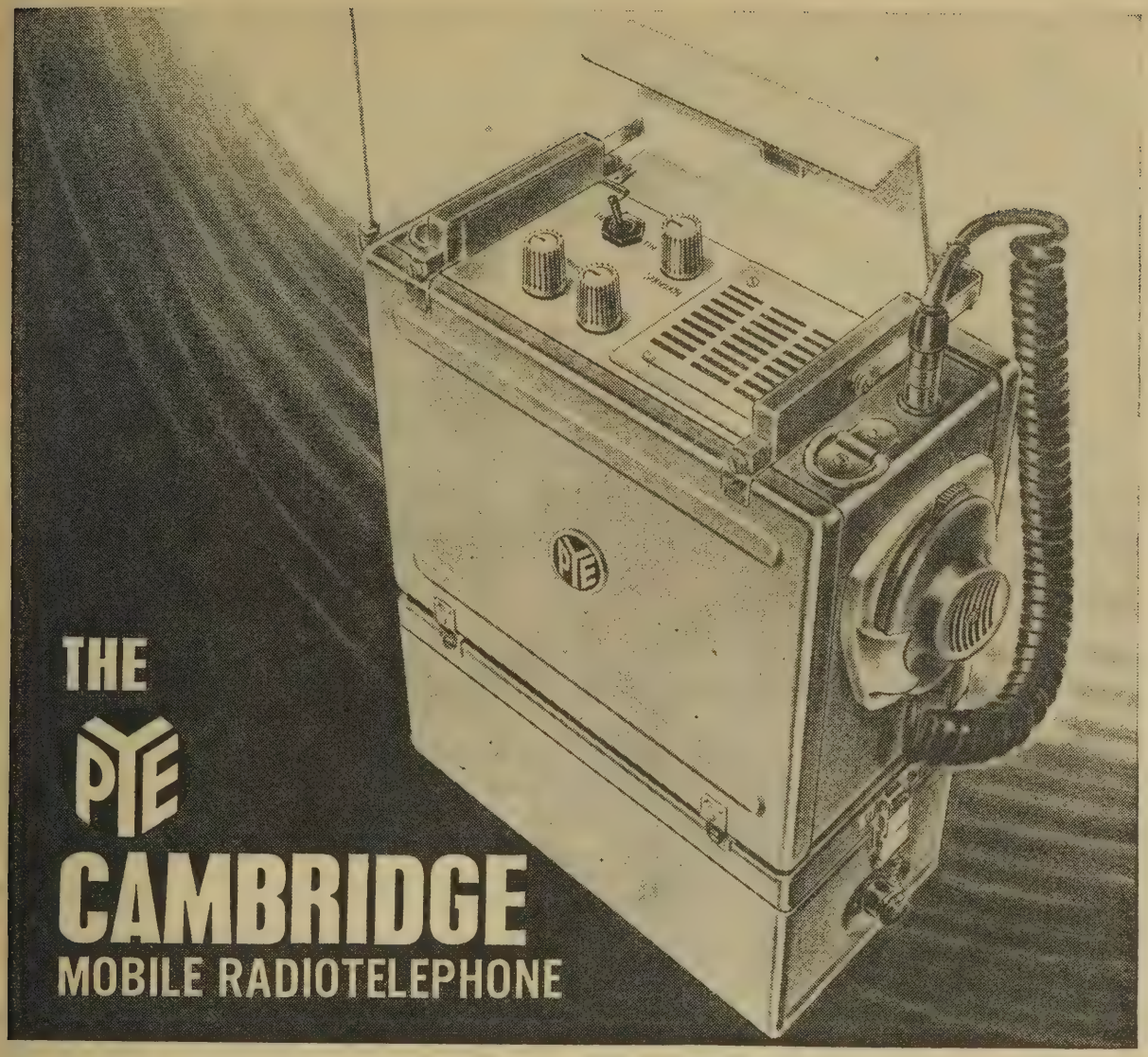
ALL Brookes Crystals are made to exacting standards and close tolerances. They are available with a variety of bases and in a wide range of frequencies. There is a Brookes Crystal to suit your purpose—let us have your enquiry now.

BROOKES

Brookes Crystals (1961) Ltd

Suppliers to Ministry of Supply, Home Office, B.B.C., etc.
CORNHILL FACTORY, ILMINSTER, SOMERSET
Tel: Ilminster 2402

14WW—077 FOR FURTHER DETAILS.



NOW-A high powered Portable!

At last—a compact, transistorised V.H.F. radiotelephone with all the power and performance of vehicle mobiles. The rechargeable battery gives up to *60 hours* duration on receive and about *18 hours* with normal use of the transmitter. The whole unit is completely weatherproofed, and is available for A.M. or F.M. systems. There is also a marine version. The answers to your questions are waiting at the address below.

- **Frequency range 25 to 174 Mc/s.**
- **Fully transistorised receiver.**
- **Standby battery drain—200mA.**
- **5 Watts R.F. output.**
- **Sealed I.F. block filters.**
- **Electronic Squelch.**
- **25 or 50 Kc/s channelling by change of filter.**
- **1 to 6 channels as required.**
- **Designed to meet British, American and European specifications.**

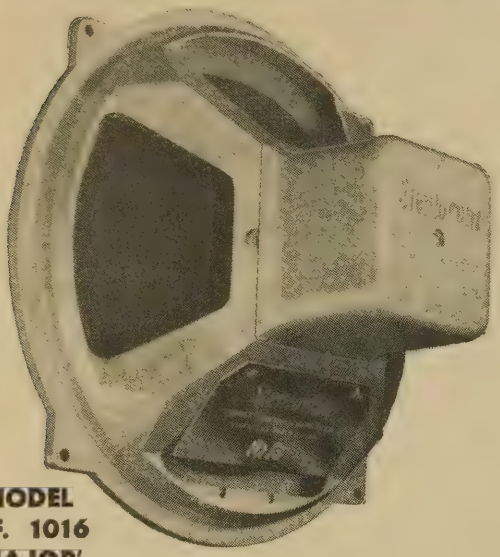
PYE TELECOMMUNICATIONS LTD.

CAMBRIDGE · ENGLAND · TELEPHONE: TEVERSHAM (CAMBRIDGE) 3131 · TELEX 81166.

14WW—078 FOR FURTHER DETAILS.

Stentorian

THE SOUND OF TODAY!



MODEL H.F. 1016 'MAJOR'

This new unit makes use of the high flux density available in the magnet system of the previous H.F. 1016 unit. A curved diaphragm is used with a rigid centre section coupled to the voice coil. The rigid coupling and the design of the cone termination give a balanced response over the whole audio range. The unit is specially suitable for use in the smaller type of enclosure having a volume of approximately 1½ cubic feet.

Specification: Chassis—die cast aluminium; Cone—graded pulp cambric surround; Cone dia.—10in.; Pole dia.—1in ; Flux density—16,000 gauss; Total flux—64,000 maxwells; Impedance—15 ohms.

Price: £9. 8. 6

Other Stentorian Speakers

Type	Flux Density	Price
10″ H.F.1012*	12,000 gauss	£4 12 0
8″ H.F.816*	16,000 gauss	£6 6 0
8″ H.F.812*	12,000 gauss	£3 16 6
8″ H.F.810	10,000 gauss	£2 17 0
T359 tweeter	9,000 gauss	£1 12 3
T816	16,000 gauss	£5 19 3
T12 tweeter	16,000 gauss	£13 17 9
T10 tweeter	14,000 gauss	£4 12 9

**These three speakers incorporate a universal impedance speech coil.*

CROSSOVER NETWORKS: CX3,000 £1.13.3
CX1,500 £2.2.0 CX500 £1.8.9

WHITELEY ELECTRICAL RADIO COMPANY LTD.
MANSFIELD · NOTTS · Tel: Mansfield 1762/5
London Office: 109 Kingsway, W.C.2.
14WW—079 FOR FURTHER DETAILS.

SOLDER WITH PRIMAX and PRIMAXA SUPER EFFICIENT SPOTLIGHT SOLDERING GUNS

Distributors: S. KEMPNER LTD., LONDON, W.1
29 PADDINGTON STREET, Tel. HUNter 0755

14WW—080 FOR FURTHER DETAILS.

WHY PAY £££'s MORE FOR SUPER REGULATION YOU MAY NEVER NEED?

FIXED or VARIABLE High Current outputs of 12-24v. up to 24A. standard (other units available to order).

Ripple content negligible. Impedance and regulation equivalent to accumulator performance. Output impedance .4 ohm at 100 c/s. Effective resistance .1 ohm. Inadvertent "short" protection. Long life. Silicon rectifiers, fully smoothed, sustained performance low impedance.

STANDARD APPLICATIONS OPERATING AND SERVICING TRANSISTORISED EQUIPMENT. MOBILE V.H.F. R/TEL., D.C. MOTORS, RELAYS, INDUSTRIAL POWER, etc., etc. DIRECT FROM A.C. WITHOUT THE USE OF ACCUMULATORS.

PRICES: **£14/16/- to £131/5/-.**

Please write to department C.3b for DC power supply leaflet.

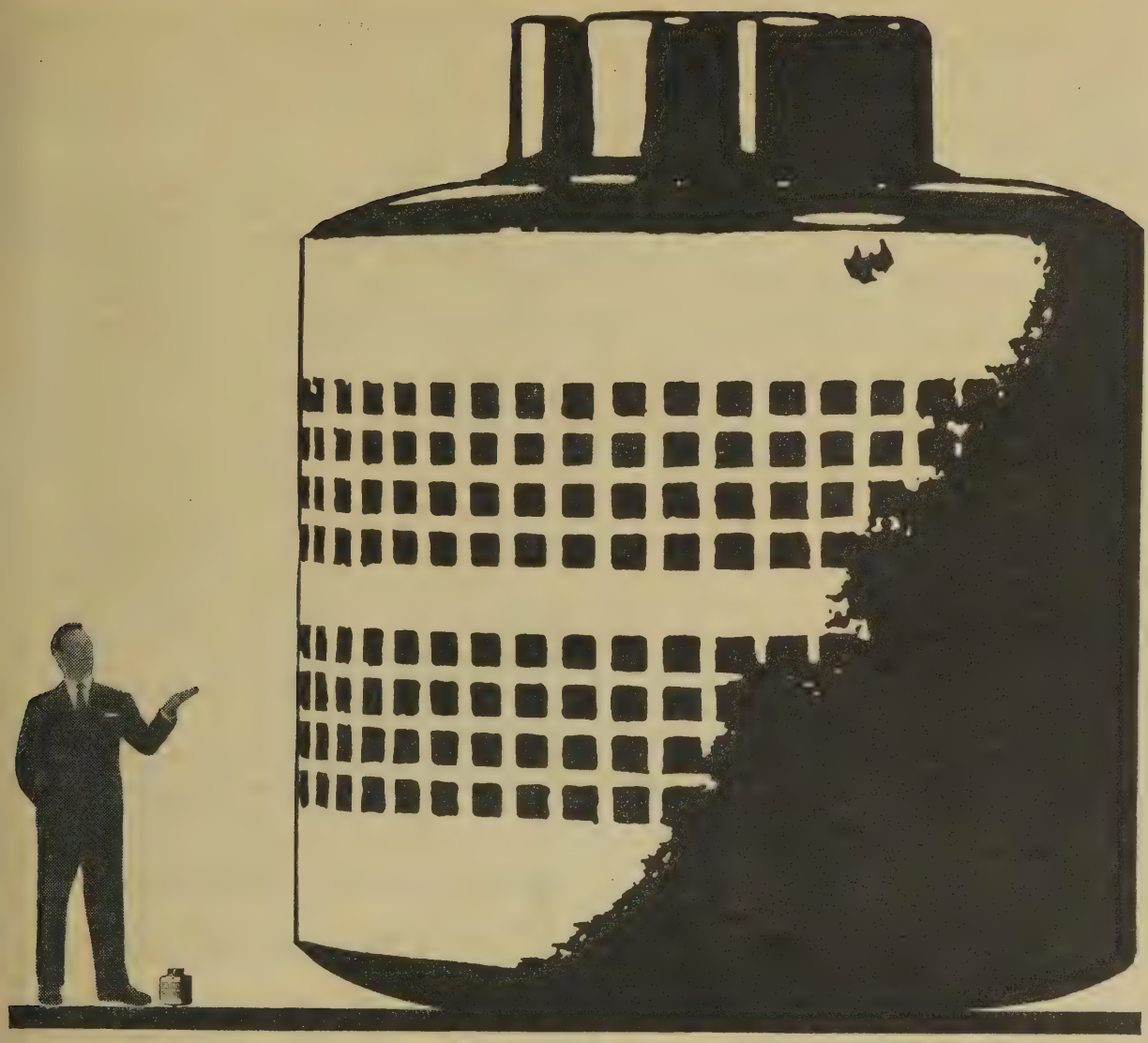
Valradio
LIMITED

250VRU/30/20

Browells Lane, Feltham, Middx. Tel.: Feltham 4242

Valradio and Stereosonoscope are the registered trade marks of Valradio Ltd.

14WW—081 FOR FURTHER DETAILS.



THE VARIAC* variable transformer is the most useful and versatile device ever developed for the control of a.c. voltage, or of current, power, heat, light, speed. It provides smooth continuous adjustment of output voltage from zero to line voltage and above, either hand-operated or motor-driven.

Only Variac has Duratrak*—a patented track surface giving longer life, increased overload and surge capacity and maximum economy in maintenance.

There are over 600 Variac models and assemblies to suit virtually every possible requirement, ranging from small units for laboratory or instrument use to large ganged assemblies for high power 3-phase operation. The range includes low-voltage, high-frequency, dual-output and narrow-range types, open, covered, portable, metalclad and oil-immersed constructions, plus many special models. This is the largest range of variable transformers available today.

The technical superiority and dependability of Variac are the result of over 30 years of development and refinement since the introduction of the first Variac models—the *original* variable transformers.

**'Variac' and 'Duratrak' are registered trade marks*

Variac

REGD

the original and best variable transformers

Variacs are made in England by The Zenith Electric Co. Ltd. London, and exclusively distributed in the U.K. Eire and British Colonies by Claude Lyons Ltd.

Write for comprehensive catalogue to Publicity Department, Hoddesdon

CLAUDE LYONS LTD

Valley Works, Hoddesdon, Herts *Hoddesdon 4541 Telex 22724*
76 Old Hall Street, Liverpool 3 *MARitime 1761 Telex 62181*

14WW—082 FOR FURTHER DETAILS. CL45

NEW!

CADRE

2-WAY CB RADIOS

SOLID-STATE TRANSCEIVERS & ACCESSORIES FOR RELIABLE, LOW COST COMMUNICATIONS

CADRE 5-Watt CB Radios

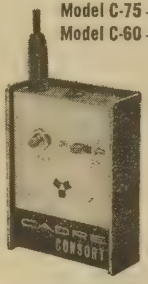
5 Watt, 5 Crystal-Controlled Channel
All Transistorized Transceiver

Model 510-A — 23 channel crystal-correlated tuner—12 VDC/110-220 VAC
Model 515-A — For AC/DC operation (same as Model 510-A less 23 channel manual tuner)
Model 520-A — DC operation mobile or field
Model 525-A — The 520-A in special portable pack

CADRE Hand Held CB Radios

2 Crystal-Controlled Channels
Rechargeable battery or penlite cell power supply
All Transistor—Built-in telescoping antenna

Model C-75 — 1.5 Watt
Model C-60 — 100 Miliwatts



CADRE Consort FM Wireless Microphone

A complete, portable wireless PA system when used with any FM radio. A wireless short range FM transmitter effective up to 200 feet from FM radio. Infinite uses.

CADRE 524 Selective Call

Solid-State Encoder-Decoder
Three tones with switching provide 24 tone combinations.
Designed to work with Cadre transceivers and other 12 VDC transceivers on the market.

Write for complete Catalog Specifications and Prices.

MORHAN EXPORTING CORPORATION

458 Broadway, New York 13, U.S.A. Cable Address: Morhanex

14WW—083 FOR FURTHER DETAILS.

M. R. SUPPLIES, Ltd.

(Established 1935)

Universally recognised as suppliers of UP-TO-DATE MATERIAL, which does the job properly. Instant delivery. Careful packing. Satisfaction assured. Prices nett.

MINIATURE RELAYS. 240 v. A.C. Switching 2 "makes" and 1 C.O. 5 amps. Size 2in. × 1½in. × 1in. New, **10/6** (despatch 1/-).

SYNCHRONOUS TIME SWITCHES (Our very popular speciality). All for 200/250v. 50 c. for accurate pre-set switching operations. Sangamo S.254, providing up to 3 on-off operations per 24 hours at any chosen time, with day-omitting device (use optional). Capacity 20-amps. Compactly housed 4in. dia. 3½in. deep. With full instructions. **£5/18/6** (des. 3/-). Also same make, same duty, Domestic Model fitted with 13-amp plug for easy installation, same price. Also Paragon, 220/250v. 50c. with 7-day dial providing for operations on four separate circuits (2 makes 2 breaks) at any required time during each day, capacity 20 amps each circuit, in metal housing 7in. × 4in. × 11in. wall mount, **£11** (des. 5/-). Also very limited offer Sangamo **£14/10/-** units, brand new, 200/250v. 50c. with 24-hour spring reserve. Up to 3 on-off operations per 24 hours. 20-amp switching, **£7/10/-** (des. 3/-).

MINIATURE RUNNING TIME METERS (Sangamo) 200/250v. 50c. synchronous. Counting up to 9,999 hours with 1/10th indicator. Only 1½in. square with cyclometer dial, depth 2in. Ideal for use with modern equipment. Immediate delivery **60/-** (post paid).

SMALL GEARED MOTORS. In addition to our well-known range (List GM/361) we offer smaller open type S.P. units, 200/250 v. A.C., e 1, 6, 12, 20 or 60 r.p.m. Size approx. 4½in. × 2½in. × 2in. with 1 in. shaft proj. Suitable for display work and many industrial uses. Only **69/6** (des. 2/6).

MINIATURE VARIABLE TRANSFORMERS (Philips). Remarkable and very popular offer from stock. Open type—panel mount, only 3½in. diameter, input 200/240 v. Output 0/240 v. 0.5 amp. (in two stages). Also the same model input 110 v., Output 0/110 v. Many applications including motor and lighting control, **58/6** (des. 2/6.).

SYNCHRONOUS ELECTRIC CLOCK MOVEMENTS (as mentioned and recommended in many national journals), 200/250 v. 50 c. Fitted with spindle for hours, minutes and central sweep seconds hands. Self-starting, central one-hole fixing. Dia. 2½in. Depth behind dial only 1in. With back dust cover **29/6** (des. 1/6). Set of three hands, brass, in good plain style. For 5/7in. dial **2/6**. For 8/10in. dial **3/6** set.

EXTRACTOR FANS. Final offer of this very popular and efficient model complete with outside cowling and indoor shutter. Circular motor housing only 4½in. dia. Easily mounted in small window pane. Silent induction motor. 200/250 v. A.C. (no interference), 3,500 c.ft./hr. Instructions with each. Only **69/6** each (despatch 3/6). We also supply our 8in. model at **£5/5/-** and 10in. model at **£5/12/6** (despatch 3/6). These models are not supplied with outside cowling. Details on request.

SYNCHRONOUS TIMER MOTORS (Sangamo) 200/250 v. 50 c/s. Self starting 2in. dia. × 1½in. deep. Choice of following speeds 1 r.p.m., 12 r.p.h., 1 r.p.h., 1 rev. 12 hrs., 1 rev. per day. Any one **39/6** (des. 1/6). Also high-torque model (G.E.C.) 2½ × 2in. × 1½in., 6 r.p.m. **57/6** (des. 1/6).

IMMEDIATE DELIVERY of **Stuart Centrifugal Pumps**, including stainless steel (most models). **Philips Variable Transformers** (all models).

M. R. SUPPLIES, Ltd., 68, New Oxford Street, London, W.C.1
(Telephone: MUSeum 2958)

14WW—084 FOR FURTHER DETAILS.

SPECIALIST SWITCHES LTD

the fastest switch service in the world

ROTARY AND LEVER TO SPECIFICATION

New customers are generally very surprised when we tell them their order will be despatched today or tomorrow-latest. They are even more surprised when they receive the switches on time. They eventually get used to all their following orders also turning up within 24 hours—and they keep coming back.

Where's the catch?

There is no catch. There are one or two limitations of course—all switches have 2in. long spindles, with no locating lugs, but this is a small price to pay for **the fastest service in the world.**

The Secret

We only make small quantities of switches to specification—We do nothing else. We are small and flexible—We need the minimum of internal paperwork—We are SPECIALIST SWITCHES.

Quantities: 1 to a dozen or so—24 hours. Around, say, 250—7 to 10 days. If you want more—come to us for your earliest requirements and go to the 'big three' for the rest.

Ask for details and prices:

SPECIALIST SWITCHES LIMITED
79a DUKE RD · LONDON W.4 · Paddington 8866-7

14WW—085 FOR FURTHER DETAILS.

TUNER + AMPLIFIER = TUNER AMPLIFIER

When a high fidelity tuner is added to a high fidelity amplifier the result is a tuner-amplifier having all the performance capabilities of the separate units.

OBVIOUS PERHAPS

But do you know that the tuner-amplifier is less expensive to manufacture, thereby providing equivalent quality to separate units at a lower price? It is more compact, takes up less room in a cabinet, or with its own case. Installation is easier, with less connecting to do, just mains and loudspeaker and it's ready to operate. Model 227 is literally our Model 222 Stereo Integrated Amplifier and Model 223 Tuner, combined in one unit. 226 is the same but with additional inputs for magnetic pickups, treble filter, tape monitor and loudness controls. 227M is a mono version of 227, and each model is the basis of a complete high fidelity system, with radio, record reproduction, tape recording and playback. The simple addition of an Armstrong Multiplex Decoder makes the stereo models ready for stereo broadcast. Each unit may be built into your own cabinet or our optional case (as shown). Teak and Vinyl hide £3.10.0. For full details and technical specifications of complete range plus list of over 300 stockists, post coupon or write, mentioning 2WW-11-64.

These models have been selected by The Council of Industrial Design for The Design Centre, London, where 227 is on display.

Model 227 has been selected for exhibition at the 1964 Triennale, Milan.

Wright&Connor

226
STEREO
£61-0-0

227
STEREO
(illustrated)
£52-15-0

227M
MONO
£36-15-0

Name

Address

2WW-11-64

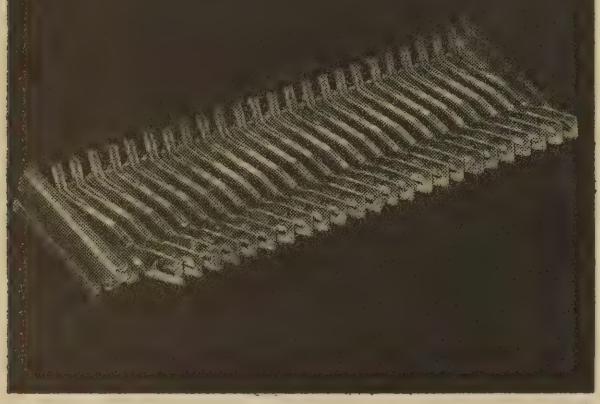
tel NORTH 3213

Armstrong

ARMSTRONG AUDIO LTD. · WARLTERS RD. · LONDON, N.7

14WW—086 FOR FURTHER DETAILS.

'Point 1' Series
laminated edge connectors



30/2

Cinch "Point 1" series laminated edge connectors offer designers many advantages. Any number of ways from 1 to 40 — Low cost — Quick, easy assembly — No moisture traps — Positive operation with maximum and minimum board thicknesses — Ribbed contacts — Various contact tail styles for solder and solderless termination — ·2" pitch up to 20 ways. With their complementary "Standard" and "332" series, Cinch laminated edge connectors offer the most comprehensive and versatile range of designs available.

SPECIFICATION		
	Current Rating	— 3 amps per contact
	Working Voltage	— 350V D.C.
	Proof Voltage	— 1.7 KV D.C.
	Contact Resistance	— 5mΩ

CARR FASTENER CO LTD

the firm with the best connections

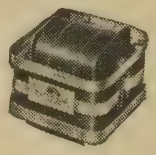
Stapleford, Nottingham · Tel: Sandiacre 2661

Cinch TRADE MARK

York House, Empire Way, Wembley, Middx. Tel. DILigence 1255/9
Crossford Court, Dane Road, Sale, Cheshire. Telephone Sale 4213/4

14W W—087 FOR FURTHER DETAILS.

THINK OF A TRANSFORMER



With over 5,000 standard production types, including many specially made for designs published in the technical press, it is certain that the transformer you need for your project is in the

Partridge

RANGE

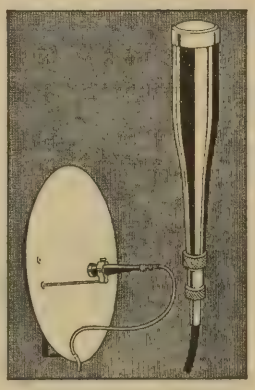
Ask for the latest Data Sheets, which include details of Transistor types for circuits published in "Wireless World", July and August 1963

PARTRIDGE TRANSFORMERS LTD.

Roebuck Road, Chessington, Surrey.
Telephone: Lower Hook 4353-4-5

14W W—088 FOR FURTHER DETAILS.

a Whole World of users can't be wrong!



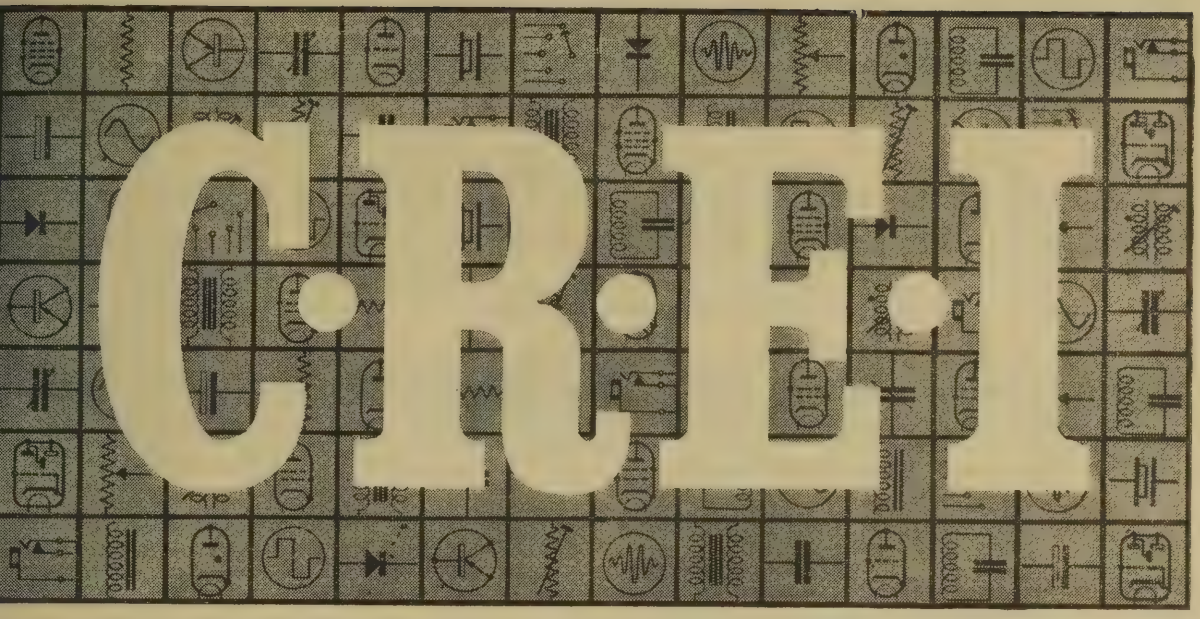
One of the really outstanding microphones in the medium-price range, the **DP/4** is enjoying unparalleled success. Small wonder, for the **DP/4** is wonderfully reliable and sensitive to an extremely wide range of sounds. Uniform frequency response from 50 c/s to 15 Kc/s.
It is in world-wide use for high-quality broadcasting, recording and public address both by the amateur and professional.
The **Parabolic Reflector**, its natural partner, focuses a distant sound-source onto the microphone head, greatly amplifying it without loss of realism and without unwanted side-noises.
Low impedance microphone, complete with connector and 18ft. screened lead £8. Medium and high impedance models £9. Parabolic Reflector 2ft. dia. complete with microphone holder £6/5/-.

Further details from your dealer or from:—

GRAMPIAN REPRODUCERS LTD.,
Hanworth Trading Estate,
Feltham, Middx. FELtham 2657

Grampian
Sound Equipment—
Integrity that you hear

14W W—089 FOR FURTHER DETAILS.



Four letters of introduction to a successful career in electronics

Four letters—standing for CAPITOL RADIO ENGINEERING INSTITUTE, Washington, D.C., of which C.R.E.I. (London) is the International Division

The new C.R.E.I. (London) Brochure describes the wide areas of study available in the 1964 HOME STUDY COURSES. The programmes extend into every application of electronic engineering, and are flexibly arranged so that appropriate courses are available for each grade of student, from junior technician to senior engineer. Every course offers a clear-cut path to increased knowledge, and brings the student right up-to-date with modern developments and techniques.

On enrolment each C.R.E.I. student is allotted a highly qualified tutor who maintains a personal interest in his progress throughout the entire course.
Special programmes for the City and Guilds of London Institute Telecommunication Technicians' Syllabuses Nos. 49 and 300 have been prepared by C.R.E.I. (LONDON) who are members of the City and Guilds of London Institute.

C.R.E.I. (London) (Dept. WW48), WALPOLE HOUSE, 173/176 SLOANE STREET, LONDON, S.W.1

C.R.E.I. Courses are available in:—

- Electronic Engineering Technology
- Mathematics for Electronic Engineers
- Telecommunications
- Automation
- Radar
- Servo Systems
- Space Electronics
- Nuclear Engineering Technology
- City and Guilds of London Institute Telecommunication Technicians' Syllabuses.

Please send me (for my information and entirely without obligation) full details of the City & Guilds Programme. (C. & G. SUBJECT 49)

☐ 1st yr. ☐ 2nd yr. ☐ 3rd yr. ☐ 4th yr.
☐ Supplementary Studies (Subject 300).

NAME.....

ADDRESS .....

.....

Educational and Technical Background

.....

.....

C.R.E.I. (London) (Dept. WW48)
Walpole House, 173/176 Sloane Street, S.W.1.

Please send me (for my information and entirely without obligation) full details of the Educational Programmes offered by your Institute.

NAME.....

ADDRESS .....

.....

ELECTRONICS EXPERIENCE.....

.....

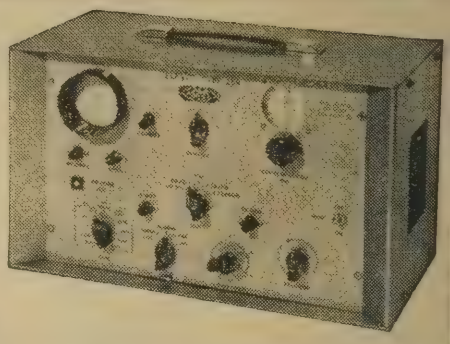
.....

.....

C.R.E.I. (London) (Dept. WW48)
Walpole House, 173/176 Sloane Street, S.W.1.

14WW—090 FOR FURTHER DETAILS.

The **only** all-in T.V. tester



THE AIRMEC TELEVET TYPE 259 is the ONLY complete Television Tester—it has every facility for thoroughly checking, repairing, overhauling and aligning TV sets. It covers Bands 1 and 111, crystal calibration. Can be used with AC/DC type sets. Completely portable. *Incorporates:* Wobbulator · AM or CW Signal Generator · Pattern Generator · Audio Oscillator · AC and DC (including EHT) voltage measuring facilities · Line transformer test.

WRITE NOW for full details! Immediate delivery

Airmec also make the RADIVET TYPE 211, for AM and FM Receivers.

Airmec Ltd HIGH WYCOMBE BUCKS Tel: High Wycombe 21201 10

14WW—091 FOR FURTHER DETAILS.

The Lexor "DIS-BOARD" for INSTANT MAINS

HIGHLY VERSATILE PORTABLE POWER DISTRIBUTION BOARDS

OVER 300 COMBINATIONS AVAILABLE FROM STOCK

Full literature and price lists from:

LEXOR ELECTRONICS LIMITED

ALLESLEY OLD ROAD COVENTRY

14WW—092 FOR FURTHER DETAILS.

IMPEX ELECTRICAL LIMITED

1 GOWER ST., LONDON, W.C.1. MUSeum 9777

IMPEX SEMICONDUCTORS

Supplies are available of fully tested semiconductors with slightly relaxed specifications. Continuity of supply is always assured. Availability list upon request.

S49T—germanium LF power transistor
V_{CB} max. = V_{CE} max. = −36V; I_E max. = 3.6A;
I_B max. = 450mA; p tot max. = 12W;
I_{CO} (V_{CB} = −0.5V) < 90μA; h_{FE} = 12 to 25.

S69T—germanium power amplifier transistor for V.H.F.
V_{CB} max. = V_{CE} max. = −28V; h_{FE} >7;
p tot max. (at 80Mc/s, 81.5mA) >300mW;

S91T—silicon junction transistor similar to OC204
V_{CB} max. = V_{CE} max = −14V; I_E max. = 450mA;
I_B max. = 90mA; I_{CO} (V_{CE} = −6V) <0.3μA;
f_t (V_{CE} = −6V I_C = 1MA) = 1.5Mc/s; h_{FE} >14.

TRADE ONLY

14WW—093 FOR FURTHER DETAILS.

THE PEMBRIDGE COLLEGE OF ELECTRONICS PROVIDES TRAINING IN RADIO AND TELEVISION

FULL-TIME COLLEGE COURSE IN RADIO AND TELEVISION

Our Course has now been extended to sixteen months' duration to include theoretical and practical instruction on transistor television receivers, U.H.F. television receivers and colour television.

Next Course commences 5th January, 1965.

This Course is recognised by the Radio Trades Examination Board (R.T.E.B.) for the Radio and Television Servicing Certificate examinations.

Provides excellent practical experience on valve and transistor radio receivers and all well-known makes of television receivers.

To:
The Pembridge College of Electronics (Dept. P10)
34a Hereford Road, London, W.2.

Please send, without obligation, details of the Full-time Course in Radio and Television.

Name .....

Address .....

.....

CMP 3

14WW—094 FOR FURTHER DETAILS.

RACAL Digital counters combine versatility with economy

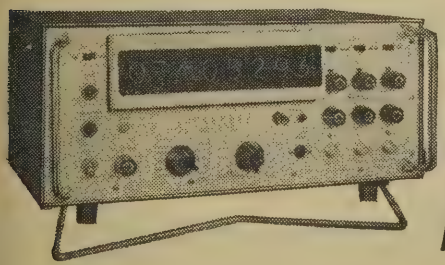
SA.550 N.A.T.O. Codification 6625-99-971-8519

Racal SA.550 100 Mc/s Digital Frequency Meter

Direct Frequency Measurements from signal levels as low as 100 mV are possible without tuning or interpolation. Measurement capability can be extended by the use of the active probe unit type SA.544.

- ☐ All Solid-State Design
- ☐ 8 Digit Inline Display
- ☐ 0-55°C. operating Ambient
- ☐ D.C. Logic Switching
- ☐ Digital Printout Facilities
- ☐ Internal or External Standard

The SA.540 Universal Counter Timer illustrated below is for time, period and frequency measurement up to 11 Mc/s.



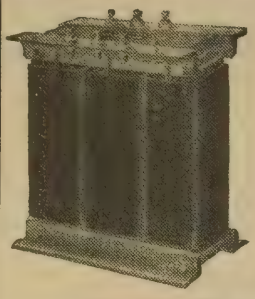
SA.540

RACAL

Write for fuller details to:
Racal Instruments Ltd.,
Dukes Ride, Crowthorne, Berks.
Tel: Crowthorne 2272/3 or Bracknell 941 Telex

RI/A64

14WW—095 FOR FURTHER DETAILS.



1 PHASE AND 3 PHASE

0.5 KVA TO 250 KVA

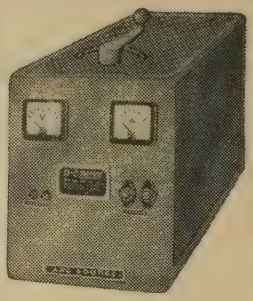
TRANSFORMERS

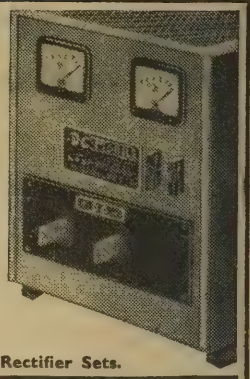
RECTIFIER SETS

100 W 150 kW
FIXED OR VARIABLE OUTPUT
1 PHASE & 3 PHASE

Electro-Plating, Plasma, Arc Welding, Electro-Magnets, Carbon Arc, Battery Charging and other uses.

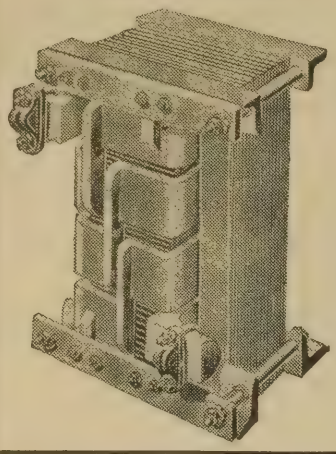
Plasma Arc Sets and other specialized equipment for gas, vacuum and powder techniques. Power Control by saturable reactors and other methods.





Variable Output D.C. Sources

Low Voltage High Current Rectifier Sets.



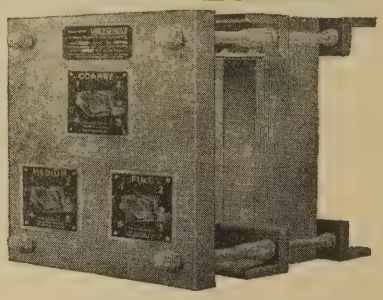
HIGH CURRENT TRANSFORMERS

1 Phase and 3 Phase

Output currents of hundreds or thousands of amperes for Furnaces, Rectifier Sets, Heat Runs, Short Circuit Testing and other uses.

Examples: 5V300A, 10V1,000A, 20V3,000A, 5V6,000A.

VOLTMOBILE



64 STEP ON LOAD SWITCHING AUTO-TRANSFORMERS

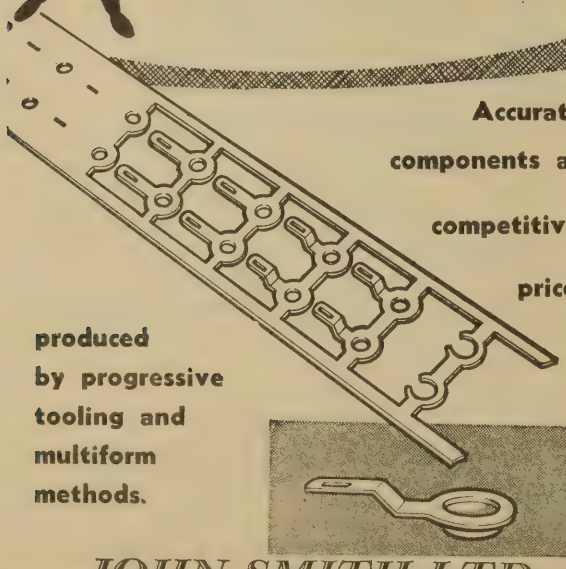
Output 1.6% to 100% or 125% of input volts in 64 steps or 80 steps. A control device for many loads—resistance furnaces, rectifier sets, battery charging, anodising, heating and other uses. 1 Phase and 3 Phase. 18 Models.

Output currents from 20 A to 200 A.

HARMSWORTH, TOWNLEY & CO.
2 Harehill, Todmorden, Lancs.
Telephone: Todmorden 602

14WW—096 FOR FURTHER DETAILS.

PRECISION PRESSINGS



Accurate components at competitive prices produced by progressive tooling and multiform methods.

JOHN SMITH LTD.
209 SPON LANE · WEST BROMWICH · STAFFS. TELEPHONE WES 2516
"MITRE MILLS" RICHARD STREET · BIRMINGHAM 7
TELEPHONE ASTon Cross 2218 (4 lines)
14WW—097 FOR FURTHER DETAILS.

MANUFACTURERS OF MACHINES FOR

AUTOMATIC & HAND COIL WINDING, LAYER, WAVE AND CONTINUOUS STRIP WINDING

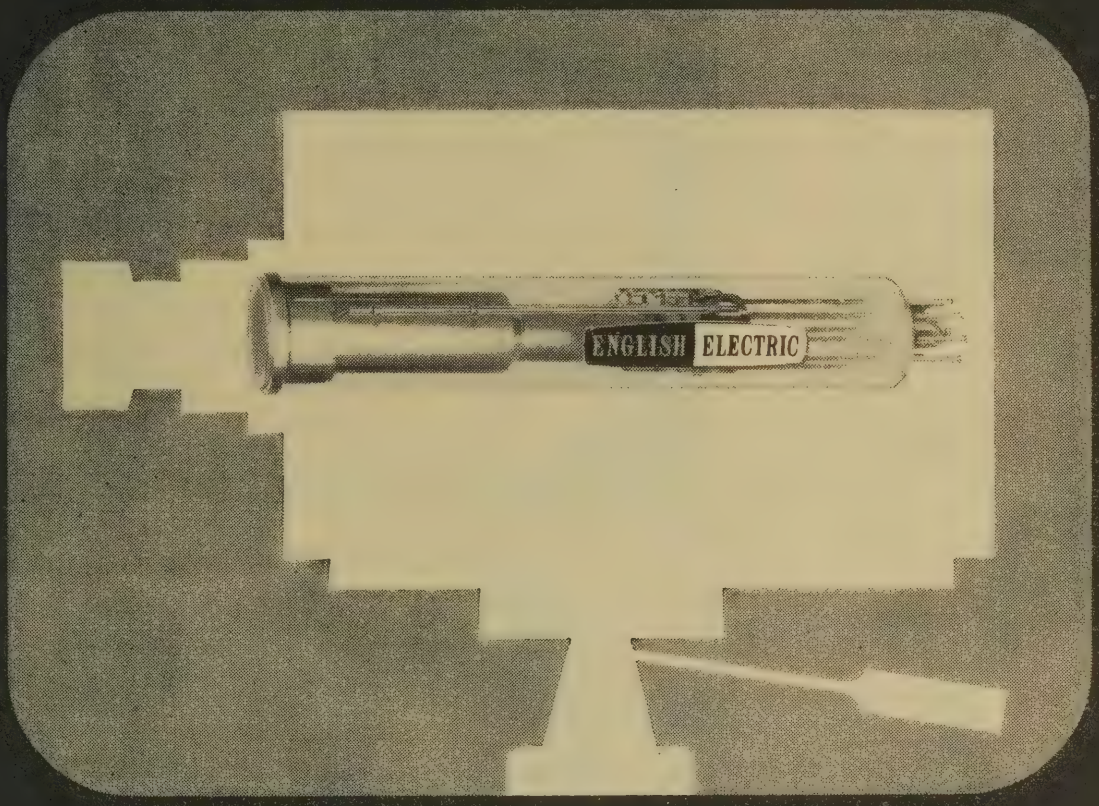
REEL CARRIERS (Light & Heavy)

Machines supplied to customers' requirements.
Your enquiries are invited

ETA TOOL CO.
(LEICESTER) LTD.
29A WELFORD ROAD, LEICESTER
Phone 56386

14WW—098 FOR FURTHER DETAILS.

'ENGLISH ELECTRIC'



VIDICONS

The basis of Compact Low Cost TV Systems

EEV separate mesh 1-inch high resolution vidicons for studio, CCTV and OB applications.

Separate mesh construction gives resolutions up to 1000 T.V. lines for these NEW Tubes.

P831 This tube features a low power 0.6 watt heater. It is ruggedised for industrial and military applications and has a short overall length.

P842 (JEDEC 8541) The P842 also features a low power heater and is intended for the majority of broadcast, educational and industrial applications. A graded version is available for colour and special broadcast purposes.

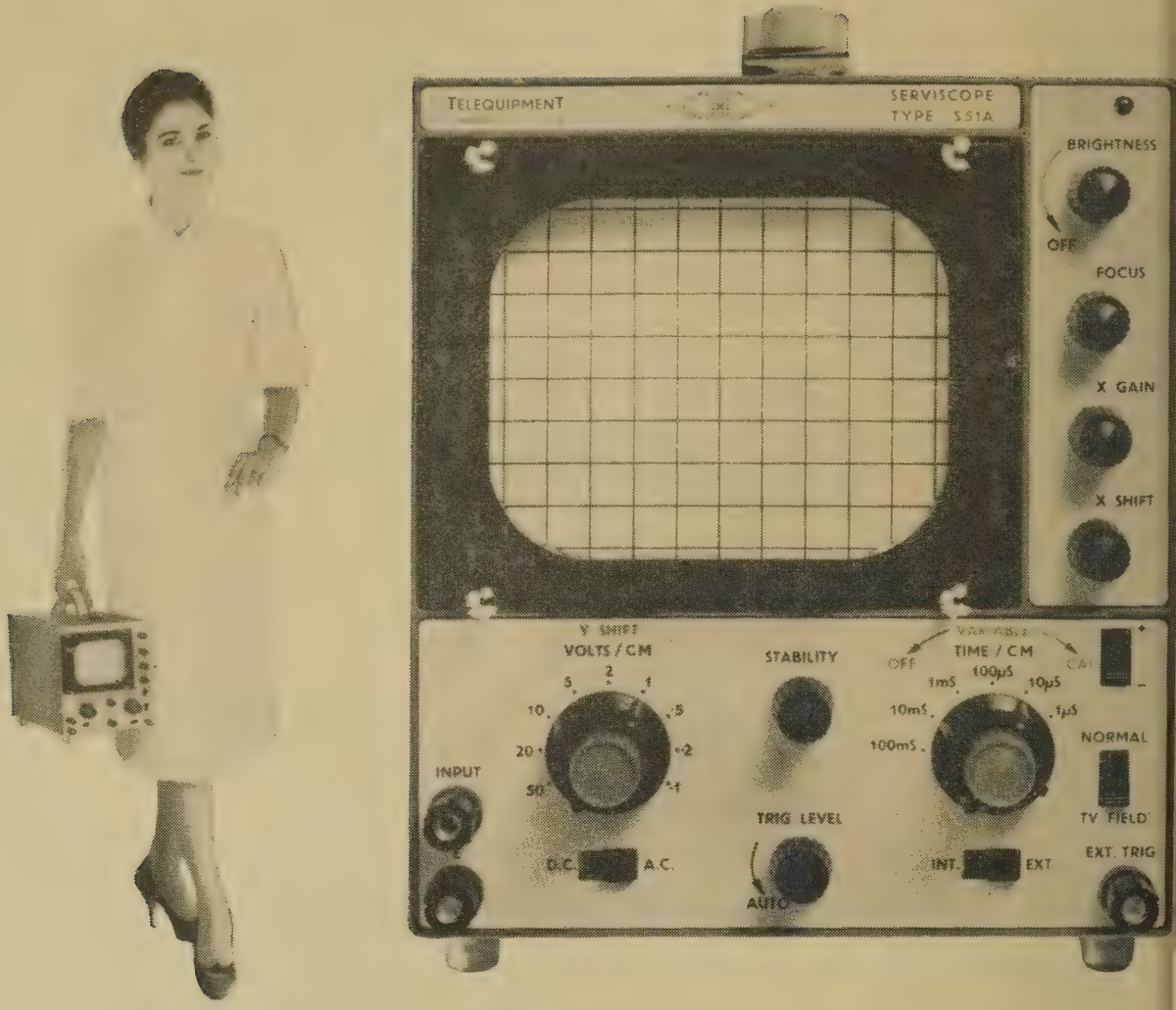
P841 (JEDEC 8507) This tube is a standard 4 watt heater version of the P842 and is designed for use in existing equipment.

Information on the complete range of television camera tubes, including 4½ and 3 inch Image Orthicons is available on request.

14WW—099 **FOR FURTHER DETAILS.**

ENGLISH ELECTRIC VALVE COMPANY LIMITED

AGENTS THROUGHOUT THE WORLD | Chelmsford, England. Tel: Chelmsford 3491 Ext. 262



5" OSCILLOSCOPE FOR £49

The Serviscope* type S51A is an instrument of good general specification with as large display — on a 5" flat-faced screen, PDA tube — as is normally available on a portab oscilloscope today. It has been designed and built to make successful operation b non-technical personnel possible; the simplicity of the controls, the ease of reading an the ruggedness of its construction make it eminently suitable for general use in industr Applications include inspection, production control, training and monitoring.

This new Serviscope is the latest in a line of portable, reliable, low-cost instrumen which are playing an increasingly useful role in the world of electronics. A descripti leaflet giving full specifications of the S51A will be sent on request.

Max. bandwidth 3 Mc/s (— 3dB approx.) · Max. sensitivity 100 mV/cm · Calibrated inp attenuator 100 mV/cm to 50 V/cm · 6 preset sweep speeds plus 10:1 variable contr Automatic sync. trigger with level control · DC coupled flyback blankin
Medium or long persistence tube phosphors at no extra cost

SERVISCOPE type S51A

**Serviscope' is a registered trade mark of*
Telequipment Limited, 313 Chase Road, Southgate, London, N.14 · Fox Lane 11

TELEQUIPMENT

14WW—100 FOR FURTHER DETAILS.

Wireless World

ELECTRONICS, RADIO, TELEVISION

CONTENTS

NOVEMBER 1964

Editor:
F. L. DEVEREUX, B.Sc.

Assistant Editor:
H. W. BARNARD

Editorial:
D. C. ROLFE
G. B. SHORTER, B.Sc.

Drawing Office:
H. J. COOKE

Production:
D. R. BRAY

Advertisements:
G. BENTON ROWELL
(Manager)
J. R. EYTON-JONES

543 Editorial Comment
544 Constant Luminance — *By I. Macwhirter*
549 Microwave Techniques—4 — *By K. E. Hancock*
555 Television Distribution by Wire—2 — *By R. I. Kinross*
559 Commercial Literature
560 Letters to the Editor
563 Coherence — *By "Cathode Ray"*
567 Congress on Microwave Tubes
569 Elements of Transistor Pulse Circuits—10 — *By T. D. Towers*
575 World of Wireless
577 Personalities
578 News from Industry
580 Fourth International Battery Symposium
581 Practical Transistor Circuit Design—3 — *By G. P. Hobbs*
586 H.F. Predictions—November
587 Manufacturers' Products
590 Recent Technical Developments
592 November Meetings

VOLUME 70 No. 11
PRICE: 2s 6d.

FIFTY-FOURTH YEAR
OF PUBLICATION

Managing Director: W. E. Miller, M.A., M.I.E.R.E
Iliffe Electrical Publications Ltd., Dorset House, Stamford Street, London, S.E.1

Please address to Editor, Advertisement Manager or Publisher as appropriate

© **Iliffe Electrical Publications Ltd., 1964.** Permission in writing from the Editor must first be obtained before letterpress or illustrations are reproduced from this journal. Brief extracts or comments are allowed provided acknowledgement to the journal is given.

PUBLISHED MONTHLY (4th Monday of preceding month). *Telephone:* Waterloo 3333 (70 lines). *Telegrams:* "Ethaworld London Telex." *Cables:* "Ethaworld, London, S.E.1." *Annual Subscriptions: Home* £2 0s 0d. *Overseas* £2 5s 0d. *Canada and U.S.A.* $6.50. Second-class mail privileges authorised at New York N.Y. BRANCH OFFICES: *BIRMINGHAM:* King Edward House, New Street, 2. *Telephone:* Midland 7191. *BRISTOL:* 11, Marsh Street, 1. *Telephone:* Bristol 21491/2. *COVENTRY:* 8-10, Corporation Street. *Telephone:* Coventry 25210. *GLASGOW:* 123, Hope Street, C.2. *Telephone:* Central 1265-6. *MANCHESTER:* 260, Deansgate, 3. *Telephone:* Blackfriars 4412. NEW YORK OFFICE U.S.A. : 111, Broadway, 6. *Telephone:* Digby 9-1197.

MULLARD 'PANORAMA'

SPECIAL BENEFITS OF 'PANORAMA'

The benefits to be gained from the absence of any protective panel in a television receiver, when a 'Panorama' tube is fitted, are fourfold:

1. Problems of dust accumulation between the faceplate and the panel are eliminated, and the difficulty of maintaining an efficient dust seal between faceplate and panel is removed. There can be no inaccessible dust to spoil the brightness of the picture.

2. The number of reflecting surfaces between the viewer and the picture is minimised. Reflections of internal and external light are thus reduced and picture-contrast accordingly improved.

3. Greater freedom is allowed for cabinet styling since, in conventional receivers, the style is dictated to a large extent by the need to provide the safety screen.

4. Smaller and lighter receivers with better physical stability are possible. Absence of the panel eliminates the space between the faceplate and the screen, and gives a better distribution of weight. (Use of the 'short' electron gun also contributes to shallow cabinets.)

Mullard

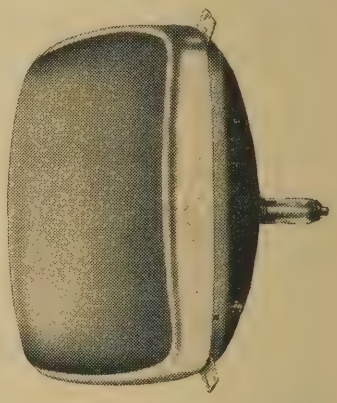
What's new in the new sets

DIRECT VISION PICTURE TUBES

'Panorama' direct vision picture tubes represent a new concept in tube design and have been introduced by Mullard to complement their existing range of 'Radiant Screen' tubes.

From the earliest days of popular television, research and development by Mullard on picture tubes have produced a steady progression of advancements in design and performance. Tubes with small round screens and narrow deflection angles gave way to larger screens with straighter edges and steadily increasing deflection angles. New screen coatings giving brighter pictures with better contrast were introduced in the 'Radiant Screen' tubes. Improved electron guns gave crisper definition and a more lifelike picture quality.

Further improvements in screen shape resulted in the present-day 19 and 23-inch tubes. Use of 110-degree deflection and the 'short' unipotential electron gun enabled these larger tubes to be produced without recourse to a corresponding increase in depth of the tube. All these features have led steadily to better performance and improved receiver design and styling. All are incorporated in the Mullard AW47-91 and AW59-91 'Radiant Screen' tubes and in the 'Panorama' tubes.



Two 'Panorama' tubes, the 19-inch A47-18W and the 23-inch A59-11W, are being introduced. They are the latest outcome of continuous research by Mullard and represent a revolutionary advance in picture tube development. Reinforcement of the picture tube envelope by means of a specially designed metal band fitted around the periphery of the faceplate, has eliminated the need for a separate protective panel in front of the tube and made possible 'direct vision' viewing.

SERVICING BENEFITS

Apart from the time saving due to elimination of any dust problem, service engineers will welcome the unprecedented ease of mounting 'Panorama' tubes by means of the four fixing lugs on the metal band. With 'Radiant Screen' and 'Panorama' Mullard now offers the industry a choice of the two most advanced picture tube techniques.

MVE 5458

Wireless World

VOL 70 NO 11 NOVEMBER 1964

Why Lasers?

THE popular press, and now the enemies of James Bond in the make believe world of the cinema, have invested the laser with an aura of fantasy which is sometimes difficult to dispel. This is partly because many of us have forgotten our classical optics and cannot explain at a moment's notice how light beams are formed and why the spectral purity of laser light should permit concentrations of peak power which are several orders of magnitude above our previous experience. But there is nothing in laser light which invalidates the principle of Huygens or the laws of diffraction.

"Cathode Ray" on p. 563 of this issue explains in his inimitable style the differences between coherent and incoherent light, and those who were able to attend the conference on lasers and their applications, sponsored by the I.E.E., the I.E.E.E. and the I.E.R.E. at Savoy Place last month will also have found their feet on firmer ground after hearing the opening address by Sir Robert Cockburn and listening to the discussions.

Although the scientific interest of lasers is enormous the practical uses, to quote Sir Robert, ". . . have been somewhat limited (I almost said trivial) . . ." One of the reasons is the low continuous or mean pulsed powers available (1 to 100 watts) and the low efficiencies (1% in gaseous and solid lasers, though 30% is obtained, with lower directivity, in gallium arsenide junction lasers). Point-to-point communications through the atmosphere, although offering by present standards almost unlimited channel space, are reliable only to distances of the order of a mile. Machining and welding operations are possible—with the aid of a microscope—and the potentialities of improved radar performance by exploiting the higher frequencies to increase scanning rate without sacrifice of resolution can at present be realized only at short ranges, for lack of power. In this connection Sir Robert pointed out that an input of 10 kW was at present about the minimum requirement for a relatively modest coverage, and that with 1% efficiency the problem of getting rid of the heat was quite considerable.

The world of lasers is Lilliputian or Brobdingnagian according to the way you do your arithmetic. If by Q-switching (building up oscillations at low level in a lossy cavity and then suddenly removing the losses) you can discharge only 1 joule in 10^{-8} seconds, you can write to the papers that you have a 100-megawatt laser and no one can disprove you. With this powerful tool you can do in a day as much damage to a razor blade as a month of ordinary shaving would do, but the damage will be localized to a degree limited only by the quality of the lenses used to concentrate the beam. Concentrations of 10^{11} W/cm^2 have been reported (paper by T. P. Hughes, N.P.L.) in a spot area of 0.1 mm diameter giving, by time-resolved spectroscopy, a surface temperature of 5,000°K with a trapped underlying plasma temperature of at least 20,000°K. Light fluxes up to 10^{14}W/cm^2 are feasible in an area of a square wavelength and this is equivalent to an electric field strength of 300 MV/cm which is comparable with internal atomic field strengths.

So here we have part of the answer to the question we have posed ourselves. The laser is a powerful tool for scientific research. It is already in regular use in laboratories concerned with plasma physics and atomic energy. It has surgical precision and has already been used successfully to coagulate tissue and repair detached retinas in the eye. But it has not yet fulfilled its promise as a means of communication and will not do so until the economics of providing the environment of outer space, or otherwise removing the inimical effects of atmospheric turbulence are shown to be practicable.

Constant Luminance

ITS MEANING, PURPOSE AND PRACTICAL APPLICATION IN COLOUR RECEIVERS

By IAN MACWHIRTER,* A.M.I.E.E.

THE first colour television system which was tried and evaluated in an attempt to convey high-quality tri-chromatic information within the confines of an existing black and white television radio frequency channel, was the R.C.A. dot-sequential system.[1] This system of signal coding, developed during the late 1940's, underwent a series of subtle mathematical changes by the contributor members of the United States National Television System Committee (N.T.S.C.), before it was finally adopted by the Federal Communications Commission, (F.C.C.), as the system by which public colour television broadcasting could begin in the U.S.A. One of the major improvements to the early R.C.A. dot-sequential system, the use of constant luminance sampling, was made following a breakthrough by Loughlin[2] as a result of an analysis of the nature of the R.C.A. dot-sequential signal coupled with the known characteristics of colour vision.

The object of this article is to explain the concept of constant luminance and how the advantages to be gained from its use are obtained. In doing so, it is hoped to show that the transmission of a true luminance signal does not, of itself, necessarily permit complete constant luminance operation. Some details of the "separate luminance" principle are also given to distinguish it from constant luminance.

Band-Sharing

Three of the essential requirements for a broadcast colour television system are:—

(i) The colour signal shall provide a high-quality picture when seen on an unmodified black and white receiver.

(ii) The complete signal shall occupy no greater bandwidth than the existing black and white signal.

(iii) The colour system shall convey sufficient information for a pleasing tri-chromatic reproduction to be obtained on a correctly designed receiver.

The first requirement is satisfied by the transmission of a signal representative of the luminance of objects. The luminance signal E_Y may be derived from a single pick-up tube in a camera whose spectral response curve matches the photoptic visibility curve of the eye (Fig. 1). Alternatively, it may be formed by matrixing from suitable tri-stimulus voltages which are generated by three separate pick-up tubes within a camera as explained later.

The luminance response curve is, in any case, required for normal black and white transmissions (in practice, however, for black and white transmissions, a modified curve is commonly used which is claimed to give a superior rendition of tone values than one might predict from known theory alone). In other words, one component chosen for the colour signal, the luminance signal, could be expected to be indistinguishable from a normal black and white signal.

Having satisfied the first requirement, both in response to the colour spectrum and television signal bandwidth, the second can be satisfied only if band sharing can be used. That is to say, the additional colour information must be transmitted within the same bandwidth as the luminance signal. In colour television systems which have been proposed for public broadcasting, e.g. N.T.S.C. and SECAM, the colour information also carries luminance and the signals are in the form (E_R-E_Y) and (E_B-E_Y), where E_R and E_B are voltages representing two of the tri-chromatic variables E_R (red) and E_B (blue) and E_Y the voltage representative of luminance. The third colour component E_G is discussed later.

The bracketed components, called chrominance signals, do carry luminance since E_Y is written into each one. At the receiver they serve, on the red, green and blue phosphor stimuli, to add to or subtract from the luminance values which would otherwise be established by the signal E_Y. For example, the total red stimulus is controlled by the voltages $(E_R-E_Y)+E_Y=E_R$.

Finally, it is known that when attempting to match colours in a three-colour colorimeter, for very small angles of view it is sufficient to make a match of luminance alone, i.e. the eye appears to become increasingly less conscious of hue, and hue errors, as the field becomes narrower. Using this knowledge, it has been found possible to restrict the bandwidth of these chrominance signals to about one-fifth of the accompanying luminance signal without objectionable loss of sharpness in the colour

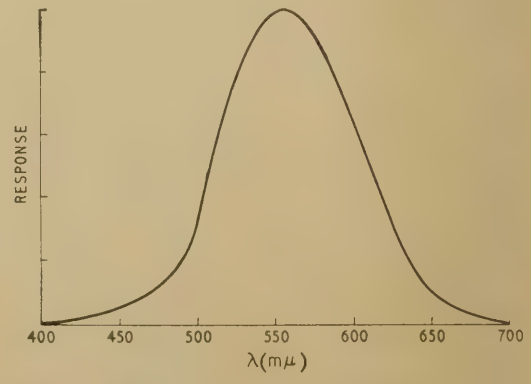


Fig. 1. Photoptic visibility curve of the human eye.

* Thorn-A.E.I. Radio Valves & Tubes Ltd.

picture or any apparent lack of colour in areas of fine detail.

The band-shared spectrum of a colour television signal is represented diagrammatically in Fig. 2.

In addition to being occupied by the luminance signal E_Y, the signal spectrum from d.c. to f_{max} is also occupied by the chrominance components which themselves modulate a sub-carrier F.

Composition of the Luminance Signal

When the luminance signal is to be formed by matrixing, the colour camera is required to have pick-up devices which produce tri-stimulus voltages E_R, E_G, and E_B. The spectral response of these devices may be calculated using a knowledge of both the particular phosphors to be used on the display and the particular white point to which the display should be matched under the conditions $E_R=E_G=E_B=1.0$. The luminance signal E_Y may be derived by adding suitable fractions of these tri-stimulus voltages thus:

$$E_Y=lE_R+mE_G+nE_B$$

The coefficients l, m and n, which are, in turn, appropriate to the particular tri-stimulus colour responses, are a direct indication of the relative luminosities (brightness) of the reproducing phosphors. The signal E_Y is, therefore, intentionally proportioned so that it has, in effect, a colour response which matches that of the eye at normal or photoptic brightness levels.

It is important to grasp, therefore, that this photoptic curve is matched equally well by the classical N.T.S.C./SECAM values where

$$E_Y=0.2989\ E_{R1}+0.5865\ E_{G1}+0.1146\ E_{B1}$$

and by a luminance equation recently derived[5] for a colour camera designed to work with the present-day sulphide phosphors and a 9300°K white point when

$$E_Y=0.1903\ E_{R2}+0.7228\ E_{G2}+0.0869\ E_{B2}$$

Normally the second suffixes 1 or 2, which relate to the phosphors and white point assumed, are omitted in technical writings and this can cause confusion as to the reason why there is not a unique set of coefficients to describe the matrixed luminance signal.

If signals of this form are used with display tubes of transfer characteristics (gamma index)γ, then the pre-corrected luminance signal should be

$$E_Y{}^{1/\gamma}=(lE_R+mE_G+nE_B)^{1/\gamma}.$$

While a signal of this form may be made by matrixing as already discussed, the elegant method is to derive the luminance signal directly from a single pick-up tube. This procedure can be shown to have advantages in the design and maintenance of camera equipment.

Reclaiming the Green Component

Since the chrominance signals chosen for transmission along with the luminance signal are commonly $[E_R-E_Y]_o^f$ and $[E_B-E_Y]_o^f$, it is necessary to re-create $(E_G-E_Y)_o^f$ at the receiver. The square brackets here indicate that these signals are band-width restricted, within the limits of d.c. to a frequency f, compared with the accompanying luminance signal. When the colour difference signals modulate the sub-carrier F, these frequency limits are transposed, e.g., the upper sideband occupies the spectrum F to $(F+f)$.

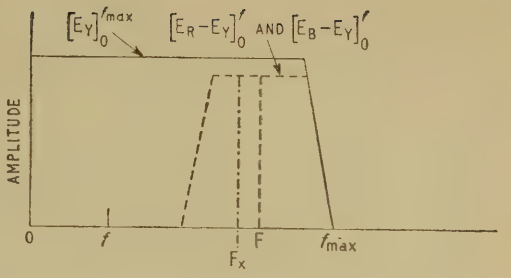


Fig. 2. The spectrum of a band-shared colour television signal.

Now the expression for the luminance signal $E_Y = lE_R + mE_G + nE_B$ may be re-arranged in the form

$$(E_G - E_Y) = -\frac{l}{m}(E_R - E_Y) - \frac{n}{m}(E_B - E_Y)$$

and this equation for deriving the green colour difference component from the two transmitted difference signals will prove to be a keystone to the successful implementation of the constant luminance principle.

At the receiver, as was indicated earlier, the original tri-stimulus voltages may be obtained as follows: for the case of red and for such low frequencies below f where the bandwidth restriction of the red colour difference channel subtracts no energy, the square brackets may be omitted.

$$\therefore\quad E_R = (E_R - E_Y) + E_Y = E_R$$

A more general equation is:—

$$E_R = [E_R - E_Y]_o^f + [E_Y]_f^{f_{max}} = [E_R]_o^f + [E_Y]_f^{f_{max}}$$

This shows that up to the chrominance cut-off frequency f, the true red signal is available. For higher frequencies corresponding to areas of picture detail between f and f_{max}, control of the display tube is by the luminance component only. This latter is applied, in the case of a three-gun shadow-mask tube, simultaneously to all guns so that fine detail is reproduced as a "black and white", or achromatic modulation upon the background colour. This is in accordance with the observed minimum requirements of the human eye as explained earlier. In the early days of the work of the N.T.S.C., the signal $[E_Y]_f^{f_{max}}$ was called the "mixed highs" signal but this term has fallen into disuse.

The Purpose of Constant Luminance

Referring to Fig. 2, it does appear inevitable that as a result of band sharing some unwanted cross-talk between luminance and chrominance components must occur. It is no encouragement to colour television engineers that the presence of the chrominance components causes disinterested viewers [3] of the compatible black and white picture to give typical quality labels of slightly poorer than "just perceptible" for the N.T.S.C. system and "definitely perceptible but not disturbing" for the SECAM system to the impairment of the picture caused by the presence of these chrominance signals.

Conversely, the parts of a colour receiver which demodulate the chrominance signals must also receive that part of the luminance signal which is band-shared. The resulting unwanted cross coupling is known as cross colour and produces spurious visible effects on the picture. Similarly, any noise

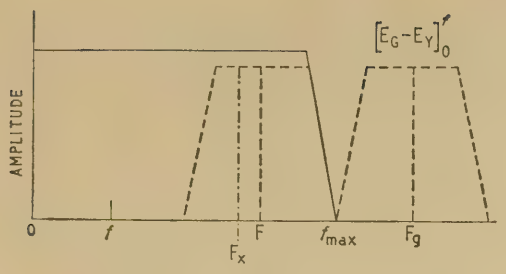


Fig. 3. Spectrum as in Fig. 2 with additional out-of-band $[E_G-E_Y]$ signal.

or interference which may be present in the band-shared spectrum will also produce unwanted spurious effect on the picture, colloquially known as 'parc'. The subjective effects of parc and cross colour are especially noticeable owing to the fact that in the process of demodulation of the chrominance signals, their frequency components are heterodyned down. Whereas band-shared components illustrated in Fig. 2, produce relatively fine-grain low-visibility effects when displayed with the luminance signal in a black and white receiver, following chrominance demodulation in a colour receiver a signal F_x in the vicinity of the subcarrier F is reproduced as $(F - F_x)$. This frequency shifting is desirable for the chrominance components but highly undesirable for the band-shared components of E_Y and noise because low-frequency signals of a given amplitude are, in general, more annoying than high-frequency signals of the same amplitude. By this heterodyning process, the susceptibility to noise and other spurious signals of a band-shared colour television system is inevitably worse than a black and white system of the same nominal channel width f_{max}.

One of the functions of constant luminance operation is to minimise the subjective annoyance of noise in the band-shared spectrum. By constraining the visible effects of noise to perturbations in hue, another feature of colour vision is involved. This is that the eye is less sensitive to changes involving hue alone than is the case when changes in luminance also occur. Loughlin's work[2] showed that provided the relative gains of the three colour difference channels are inversely related to the luminosity coefficients (relative luminosities) of the display's phosphors, then this noise protection feature can be achieved. At the same time, the transmission of all and nothing but luminance information by the luminance channel means that the bandwidth restriction of the chrominance information in no way detracts from the ability of the luminance signal to portray fine colour detail in black and white. These are two of the advantages of constant luminance working. The name "constant luminance" derives from the fact that, provided all phosphor stimuli are operating, the luminance of the display remains constant despite any change of signal level in the chrominance channel of a receiver. This is because the sum of the luminances caused by components in the band-shared channel is designed to be zero.

The old R.C.A. symmetrical dot-sequential signal[1] was called "constant amplitude" to indicate that although band-shared components produced equal *voltages* in the colour difference channels, which added vectorially to zero, the luminance effects did not.

A qualitative account of the mechanism of constant luminance can be given as follows:—

Excitation of each of the three phosphors produces luminance. The observed luminance will be the numerical sum $Y_R + Y_G + Y_B$ (the red, green and blue luminances). Hence, if a signal in the chrominance channel causes, say, an increase in the value of $[E_R - E_Y]'_0$ and $[E_B - E_Y]'_0$ with corresponding increase in red and blue luminance, then since

$$Y_G \equiv E_Y - \frac{l}{m}[E_R - E_Y]'_0 - \frac{n}{m}[E_B - E_Y]'_0,$$

it is clear that the green luminance Y_G will decrease. If the proportions are correctly chosen, this decrease in Y_G can be made to compensate exactly for the increases in Y_R and Y_B.

The mathematical relationships which govern the achievement of constant luminance are well known[4] and can also be expressed as follows for an N.T.S.C. type of transmission:

$$l^2 a^2 + n^2 c^2 = m b^2 \quad \ldots\ldots\ldots\ldots \text{(i)}$$

where a, b and c are the gains associated with red, green and blue channels of a colour receiver following unity gain demodulators; and before phosphors of (assumed) balanced efficiencies.

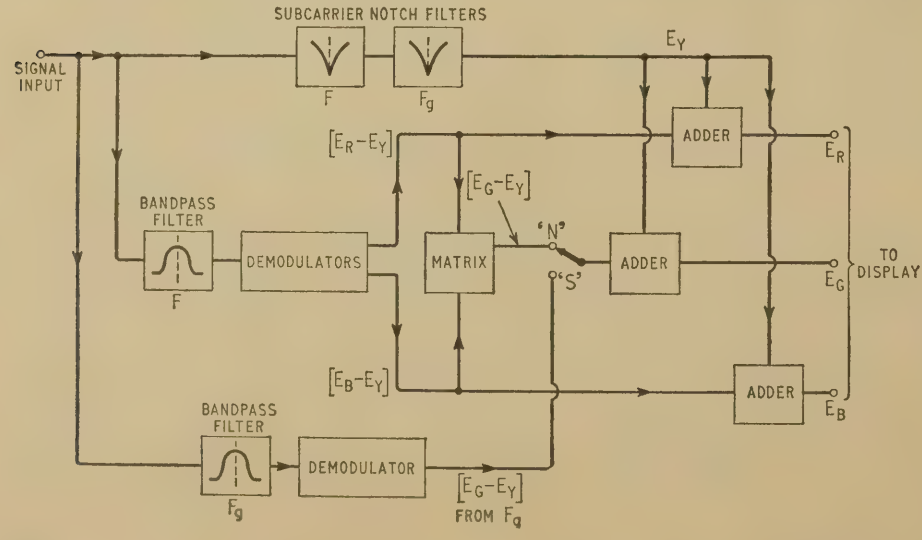


Fig. 4. A colour receiver switchable for 'normal' recovery of $[E_G-E_Y]$ or 'special' recovery.

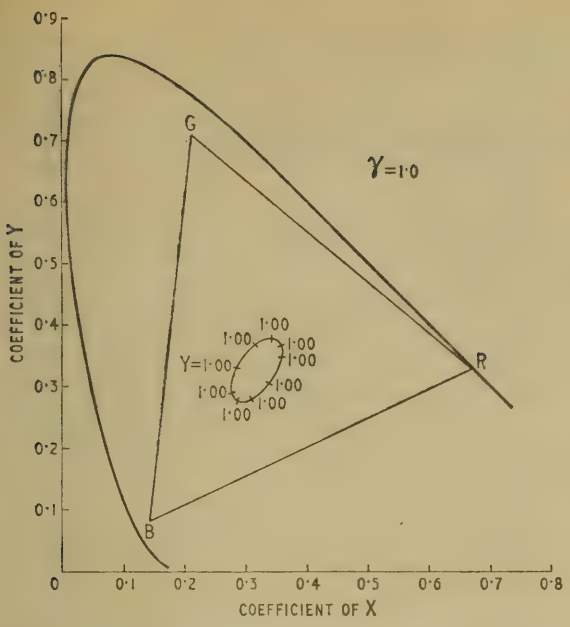


Fig. 5. Effect of a band-shared signal 0.2 sin ($F_x + \psi$) when the intended colour is white, $E_Y = 1.0$.

The Mechanism of Constant Luminance

The application of the theory can be illustrated numerically by calculating one aspect of the noise susceptibility of a receiver designed to receive the colour signal shown in Fig. 3. This will be seen to be similar to the spectrum of Fig. 2, except that the green colour difference component is independently made available on another sub-carrier F_g outside the spectrum of what would be a normal N.T.S.C. or SECAM signal. A receiver (Fig. 4) could be made switchable to be either "NORMAL," i.e. the $[E_G - E_Y]'_o$ component is derived from the other two, or to have a separate out-of-band $[E_G - E_Y]'_o$ detector ("SPECIAL" case).

In the event of a spurious signal of frequency F_x being present in the band-shared spectrum as shown in Fig. 3, and with the green channel selected as for "NORMAL" reception, the visible perturbation caused by F_x can be calculated for an N.T.S.C. type receiver and is shown in Fig. 5. It will be seen that although a cyclical change of hue is observed, depending on the phase of F_x, there is no change in the reproduced luminance. However, if the green channel switch is set to "SPECIAL," i.e. the green phosphor is not excited by signals representative of $(F - F_x)$, then not only do hue variations occur but variations in luminance as well which result in greater subjective annoyance, see Fig. 6.

For this case, although a true luminance signal E_Y is still radiated, there has been a failure of the particular noise protection feature which constant luminance should provide. In other words, the transmission of a true luminance signal does not, of itself, guarantee correct constant luminance receiver operation.

It should be clear from the foregoing that the achievement of constant luminance is essentially a receiver design problem. Specifically, it requires that one of the colour difference signals be derived from the other two, and that these two share the same band. The gains in each of the three colour difference channels should then be precisely related to the luminosity coefficients of the display's phosphors according to equation (i). The transmitted signal is then proportioned to match the requirements of the receiver.

Effects of "Gamma" Pre-correction

Display tubes used for colour television have a transfer characteristic or gamma index of about 2.8. It is necessary, therefore, to apply an inverse pre-correction in the picture originating equipment to correct for this non-linearity.

Both present-practice N.T.S.C. and SECAM signals are gamma pre-corrected in the following way: $E_{Y'} = lE_R^{1/\gamma} + mE_G^{1/\gamma} + nE_B^{1/\gamma}$ and the two transmitted chrominance components are: $[E_R^{1/\gamma} - E_Y']_o$ and $[E_B^{1/\gamma} - E_Y']_o$. (Note that this form of luminance signal can only be formed by matrixing.)

It has been shown [5] that the mathematical analysis which establishes the practical conditions for the achievement of constant luminance receiver operation is similar to, but not identical with, that of the linear case.

If this solution (equation (i)) is used in the receiver design then it follows, by definition, that the luminance signal should provide all the luminance information—and nothing more—for the correct reproduction of luminance and hue in both large and small areas of the picture. The reproduced luminance Y from the luminance signal is obviously proportional to $(E_{Y'})^\gamma$. Ideally, $(E_{Y'})^\gamma = E_Y$. This it does for the grey scale when $E_R = E_G = E_B$, but for colours the value of $E_{Y'}$ is always lower than the ideal luminance signal $E_Y^{1/\gamma}$ where $E_Y^{1/\gamma} = (lE_R + mE_G + nE_B)^{1/\gamma}$. For this latter, the luminance $Y \propto (E_Y^{1/\gamma})^\gamma = E_Y$ which is correct for all colours. The errors in hue and luminance occasioned by the use of present-

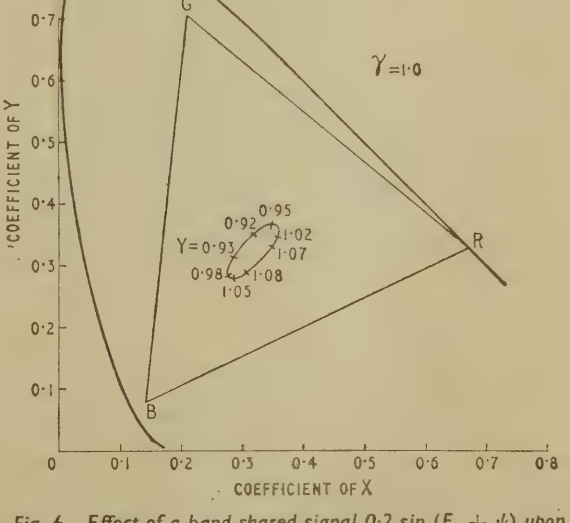


Fig. 6. Effect of a band-shared signal 0·2 sin ($F_x + \psi$) upon the intended colour, system white, but when the green signal is derived from an out-of-band signal (see Fig. 3.)

practice gamma pre-correction are small for pastel colours but rapidly worsen as saturation increases.

For large areas, the errors in luminance are limited to those caused by cross colour and parc only, for small areas which correspond to colour difference frequencies in excess of f (Fig. 2) there are luminance errors in the reproduction of picture detail as well. Unwanted errors in hue in large areas of colour are limited to those caused by cross-colour and parc. The undesired errors are aggravated by the use of display phosphors and white points which are not appropriate to the weighting coefficients assumed in the system. This condition is typical in the operation of colour television receivers today[5].

What can be said at this stage is that it does not appear possible to design an *exact* constant luminance receiver for use with the present practice N.T.S.C. or SECAM signals which gives correct colorimetry. Exact constant luminance receivers require not only more complex circuits than those used at present, but transmitted signals which are different from present practice[6]. Specifically, the complexity arises because of the need for non-linear processing of the signals. This feature is not called for when using present practice signals and in consequence the design of receivers is less costly. Whether the cost of exact constance luminance receivers outweighs the improvement in performance appears to be the subject of some controversy.

Camera Design

The particular formation of the present practice luminance signal E_Y' is the cause of another source of error. When a colour camera using separately scanned pick-up tubes is used to provide the tristimulus voltages E_R, E_G and E_B, then the amplitude of the luminance signal E_Y' is not only low for all coloured objects, as has been explained, but the maximum definition provided by E_Y' is critically dependent upon the accuracy of image registration between the three pick-up tubes. Of course, cameras can be made to provide good registration provided that particular tight tolerances are maintained. However, the problem of design and maintenance of a colour camera would be eased if one of the pick-up tubes generated directly a luminance signal. Proposals for such cameras have been made for some time[6,7] and James has suggested the use of the name "separate luminance" to describe them. "Separate luminance" can be extended to mean a system in which the terminal equipment is particularly designed so that (i) the receiver is "constant luminance" (full noise protection and no low definition chrominance information causing changes of luminance), and (ii) the camera has a "separate luminance" pick-up tube.

Observations

The problem, to which a solution of universal acceptance has not yet been found, is the composing of a specification for a correct constant luminance receiver of no worse stability and with only little more complexity than present practice receivers. Such a receiver would, by definition, provide the viewer with the advantages of both receiving signals from a camera with a "separate luminance" pick-up and having exact adherence to the constant luminance principle.

Such specifications for both the signals and receivers (including the system now attributed to Livingston) were proposed by the various industrial contributors to the N.T.S.C. deliberations during early 1953[8], but at that time the true luminance signal $E_Y^{1/\gamma}$ was derived from matrixing tristimulus voltages.

The subjective benefits of a "separate luminance" pick-up could not, therefore, have been realized. Although the studies of the N.T.S.C. Gamma Sub-Committee were never completed, the gamma specification of the final N.T.S.C. signal was worded so as to allow for the introduction of more advanced forms of gamma correction if their use was desirable.

If a colour receiver designed to work with a present practice N.T.S.C. or SECAM signal is used with a transmission containing a true luminance signal $E_Y^{1/\gamma}$ and either (a) James's colour difference components

$$[E_R^{1/\gamma} - E_Y^{1/\gamma}],\ [E_B^{1/\gamma} - E_Y^{1/\gamma}]$$

or

(b) Livingston's (N.T.S.C. Gamma Sub-Committee case II) components where the colour difference signals are identical with present practice, then hue and luminance errors will occur[6,9]. This results because the value of $E_Y^{1/\gamma}$ is always greater than E_Y' (except for the grey scale) and this will tend to desaturate all colours and reproduce them at higher than intended luminances. There is an exception to this in the case of predominantly green colours with reception from the James signal, when such colours will tend to have higher than intended saturations and luminances.

The introduction of the "separate luminance" camera has reopened this decade-old problem, which is complicated by the use of display phosphors and white points other than those written into the specification for the transmitted signal which are known to aggravate these distortions.

Acknowledgement

The author wishes to thank the management of Thorn-AEI Radio Valves & Tubes for permission to publish this article.

REFERENCES

1. "Principles and development of color television systems", G. H. Brown and D. G. C. Luck, *RCA Review*, Vol. XIV, No. 2, June 1953.
2. "Recent improvements in band-shared simultaneous color-television systems", B. D. Loughlin, *Proc. I.R.E.*, Vol. 39, No. 10, October 1951.
3. "Compatibility with camera pictures & domestic receivers", U.K. contribution to C.C.I.R. Doc. 32-E, February 1964.
4. "The constant luminance principle in NTSC color television", W. F. Bailey, *Proc. I.R.E.*, Vol. 42, No. 1, January 1954.
5. "Comparative effect of components in the band-shared spectrum of NTSC-type colour-television signals', I. Macwhirter, *Proc. I.E.E.*, Vol. 111, No. 7, July 1964.
6. "A constant luminance colour television system", I. J. P. James and W. A. Karwowski, *Journal Brit. I.R.E.*, Vol. 23, No. 4, April 1962.
7. "Recent developments and current status of colour television in the United States", G. H. Brown, I.E.E. Conference, Paper 4026E, June 1962.
8. "Principles of color television", Hazeltine Laboratory Staff, Chap. 11, Chapman & Hall, 1956.
9. "Colorimetric analysis of the NTSC color television system", D. C. Livingston, *Proc. I.R.E.*, Vol 42, No. 1, January 1954.

An Introduction to
MICROWAVE TECHNIQUES

4.—MICROWAVE COMPONENTS AND INSTRUMENTS

By K. E. HANCOCK*

HAVING dealt with microwave power sources in the previous article in this series, we will now pass on to the discussion of various microwave components. There are unfortunately a greater variety of components in use than can be dealt with here. In this article, therefore, we will concentrate on components constructed of waveguide, covering those in common use, and in particular those used in the measurement circuits to be described in the next and final article in this series.

It should be remembered, however, that most of the components described have their counterparts in coaxial line. Many are also made in stripline, a form of construction lending itself to the compact construction of complicated integrated microwave circuits.

Choke Flanges

The first component we will examine is really not a component at all, but a resonant circuit incorporated in many components for reasons shown later.

It is obviously impracticable to solder waveguide components together as we would resistors and capacitors. Instead, flat plates called flanges are attached to either end of the waveguide component. Holes in the flanges allow it to be bolted to succeeding components.

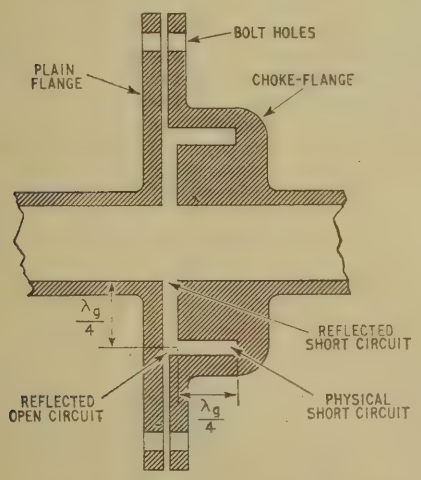


Fig. 1. Cross-section through waveguide coupling showing choke flange.

Remembering our theory of reflections and standing waves it will be obvious that to prevent reflections due to mis-alignment of the waveguides, the flanges must be exactly at right angles to the centre line of the guide, the bolt holes must be very accurately positioned and finally the complete flange face must be perfectly flat.

These conditions can be fairly easily fulfilled, at any rate to an acceptable limit for low power, but the tight tolerances make it an expensive process. In addition, at high power there is a tendency for arcing to take place over the very small gaps at the flange junctions, particularly if standing waves are present.

To overcome these problems a choke flange is used. This device, which is illustrated in Fig. 1, is essentially a $\lambda_g/2$ short-circuited line built into the flange. It will be remembered from the previous article that a half-wavelength line will reflect its terminating impedance to the input. As the choke is terminated in a short circuit, an effective short circuit will appear at the junction between the two flanges, thus preventing arcing, reflections and leakage. As any particular waveguide size is used over a range of frequencies, the standard choke flange is designed to be most effective at the centre frequency of the range.

As the normal v.s.w.r. obtained with choke flanges is from 1.03 : 1 to 1.05 : 1 they are seldom used on precision low-power test equipment, but are found on most other components. Choke flanges should always be mated with a plane flange.

Ferrite Isolators

With many power sources it is important that the load should be reasonably matched as a high v.s.w.r. can cause frequency pulling, and in some cases cause failure of oscillation. There are several methods of overcoming this, the most efficient being the use of a ferrite isolator. This is a device that passes power in one direction with little loss, whilst having a high loss or attentuation when power is propagated in the opposite direction.

There are at least three types of ferrite isolators using slightly different principles. The commonest type, the resonance isolator, will be dealt with here. The other types the reader may encounter are the Faraday rotation isolator, and the field displacement isolator. Of these less common types the former may be recognized by the fact that the ferrite is mounted in a circular waveguide which is surmounted by a magnet. The latter may be distinguished from the resonance isolator by the fact that

*Canadian Marconi Company.

two slabs of ferrite plus some form of resistive element are used.

A cross-section of a resonance isolator is shown as Fig. 2. This device is basically a slab of ferrite material mounted across the narrow dimension of a waveguide in a strong constant magnetic field. Ferrite is a magnetic material having an extremely high resistivity. A microwave signal can therefore pass through it with very little loss. All magnetic materials have free spinning electrons which give them their magnetic properties. When the ferrite is placed in a strong constant magnetic field, the axis of spin of these electrons will line up with the field. If a microwave field is present in the waveguide,

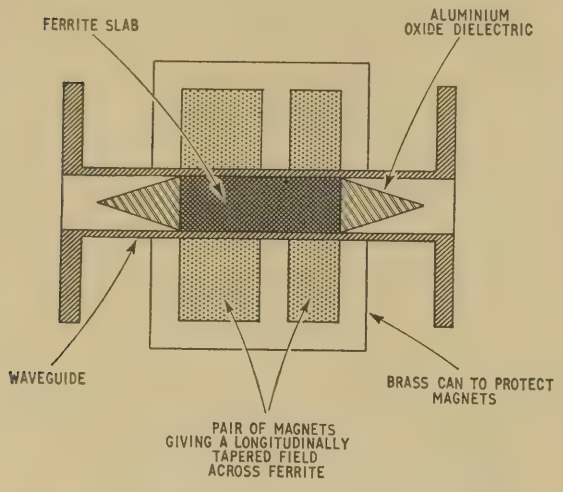

FERRITE SLAB
ALUMINIUM OXIDE DIELECTRIC
WAVEGUIDE
BRASS CAN TO PROTECT MAGNETS
PAIR OF MAGNETS GIVING A LONGITUDINALLY TAPERED FIELD ACROSS FERRITE

Fig. 2. Cross-section through a broadband ferrite isolator.

the magnetic field component will displace the axis of spin and cause it to precess about the axis of the constant (d.c.) magnetic field at a frequency, proportional to the constant magnetic field, termed the gyromagnetic resonant frequency. If the constant magnetic field is adjusted to make the gyromagnetic resonant frequency equal to the microwave field frequency, the attenuation constant through the ferrite will depend on the direction of propagation of the microwave signal. In one direction the direction of electron spin will allow the ferrite to pass the signal with little loss, whilst in the other direction will greatly attenuate it. As shown in Fig. 2, if a broadband device is required the magnetic field strength is varied over the length of the ferrite, often by using two magnets.

Ferrite devices are fairly new, and are in a continuous state of improvement. However, to give the reader an idea of the present state of the art, performance figures of two isolators currently available are given in the table. Insertion loss refers to loss in the "non-lossy" direction, whilst isolation refers to the loss in the "lossy" direction.

Frequency Range (Mc/s)	Insertion Loss (dB)	Isolation (dB)	V.S.W.R.
5,950– 6,450	0.1	30	1.05
12,400–18,000	1.5	30	1.15

Waveguide Attenuators

As in low-frequency circuits, it is often necessary in microwave work to set or adjust the power level. The microwave equivalents to the common resistor and potentiometer are the fixed and variable attenuators. In these components a resistive film designed to have little inductance at microwave frequencies is deposited on a backing element designed to give little reflection and mounted in the waveguide so that a portion of the field is absorbed by the resistive element.

Two main types of variable attenuators are used. The transverse attenuator, shown in Fig. 3, typically uses a flat lozenge-shaped element of glass, ceramic or fibreglass. On this is evaporated an extremely thin film of resistive material, often nickel-chromium alloy, only a few microns thick. The resistive element is mounted on driving rods so that it is parallel to the narrow side of the waveguide. The element is moved across the guide, often with a micrometer drive to ensure "resetability." With a well-designed element maximum attenuation is reached when the resistive element is at the centre line of the guide, the attenuation law being approximately co-sinusoidal. The normal maximum attenuation of this type of attenuator is 40 dB with a minimum attenuation of 0.1 dB. A well-designed and manufactured unit can be calibrated to give an accuracy of ± 0.02 dB or so. The main disadvantage of the transverse attenuator is the fact that attenuation varies with frequency, requiring a different calibration for each frequency used. It is, however, simple to manufacture and use, and can be made very compact.

The second type of attenuator in common use is the rotary vane attenuator, shown in Fig. 4. In this device the rectangular waveguide is transformed, usually by long tapers, to a circular waveguide. If the transitions are properly designed the H_{11} circular mode, which is very similar to the H_{10} rectangular mode, will be propagated in the circular guide. Let us divide the circular waveguide into three parts, making the centre section rotatable.

An attenuating vane, of similar construction to that

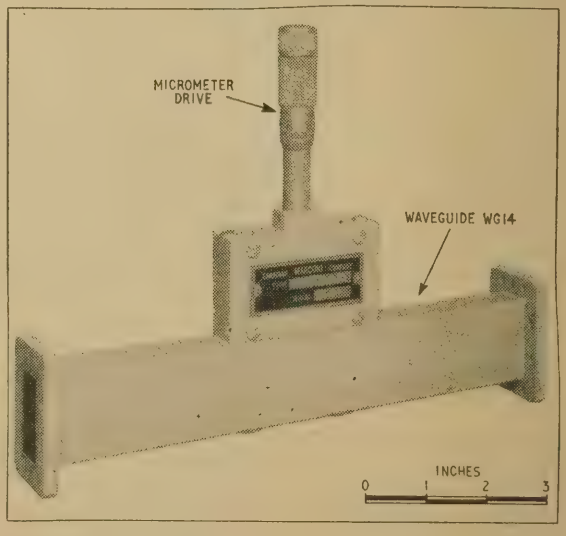


Fig. 3. Transverse attenuator with micrometer adjustment.

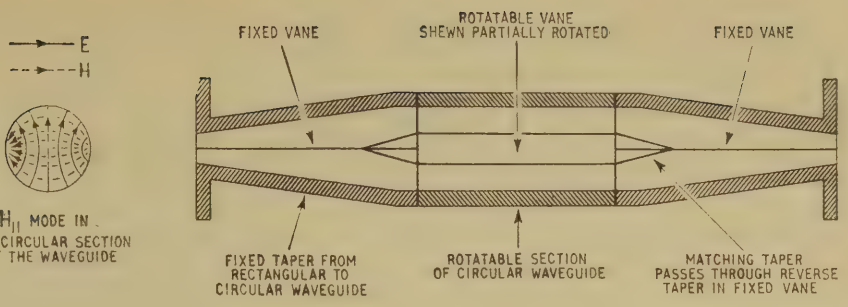

E
H
H_{11} MODE IN THE CIRCULAR SECTION OF THE WAVEGUIDE
FIXED VANE
ROTATABLE VANE SHEWN PARTIALLY ROTATED
FIXED VANE
FIXED TAPER FROM RECTANGULAR TO CIRCULAR WAVEGUIDE
ROTATABLE SECTION OF CIRCULAR WAVEGUIDE
MATCHING TAPER PASSES THROUGH REVERSE TAPER IN FIXED VANE

Fig. 4. Schematic diagram of a rotary vane attenuator.

used in the transverse attenuator, is mounted in the first fixed portion of the attenuator, passing exactly through the centre line, and in a perfectly horizontal position. If the H_{11} mode in the circular guide has not been rotated by manufacturing errors in the taper, the electric field will pass through the vane at right angles, and no attenuation will take place. If some rotation has taken place, any horizontal component of the electric field set-up will be greatly attenuated, thus effectively keeping the "E" field vertical at the horizontal centre line.

Considering now the rotatable portion of the attenuator, which contains a similar attenuating vane. When the vane is in a horizontal position no attenuation will take place, when in a vertical position maximum attenuation will occur. It can be readily seen that the attenuation will be a function of the angular movement of the vane. This function, mathematically the secant of the angular displacement, is, for an ideal attenuator, independent of frequency.

The second fixed vane in the output taper will further attenuate the signal by an equal amount, the process being similar, the final field being aligned with the output rectangular waveguide. The attenuation through the component therefore follows a secant squared law, the calibration being simply a secant squared scale. This gives a wide scale at the low end, very suitable for measuring small increments of attenuation. The scale is usually calibrated to about 50 dB, and as mentioned previously is independent of frequency. The main disadvantage of this instrument is its bulk, due to the need for long tapered transitions.

The Standing Wave Detector

To be able to measure the match of a piece of microwave apparatus, we must be able to detect and measure either the standing wave, or both the reflected and incident waves and compare them. Both methods are used, but only the former, which is the simplest and in general the most accurate, will be dealt with here. The other method, the reflectometer technique, is most suitable for swept frequency measurements, and is widely used as a production inspection tool.

As mentioned in the article on microwave theory, if a straight narrow slot is made down the exact centre of the broad wall of a waveguide, the signal will not be affected. This is the basis of the standing wave detector. A short probe is mounted in a slot of this type, and moved longitudinally along it. A current is induced in the probe proportional to the amplitude of the standing wave at the point in question. The probe signal is rectified and displayed on a meter, the difference between the minimum and maximum signals giving a measure of the v.s.w.r.

A line drawing of a standing wave detector is shown as Fig. 5. The ends of the slot are usually tapered as an additional aid in preventing reflections. Great care is taken to keep the slot parallel with the sides as any variation will, of itself, give a variation of output and thus an error in the v.s.w.r. measurement. The probe depth must be kept constant for the same reason. The runners of the probe carriage must therefore be machined accurately flat over the whole distance of travel. Similarly the bearings of the probe carriage rollers must have minimum eccentricity as this will give a cyclic variation of probe depth.

The probe itself consists of the inner and outer sections of a coaxial line. The inner section projects into the waveguide. The probe depth is often variable, although an empirical optimum depth frequently used is $12\frac{1}{2}\%$ of the narrow dimension of the waveguide. The outer sheath of the coaxial probe must be aligned within the inside wall of the waveguide. If this is not done radiation into the slot from the inner conductor can occur, creating a slot wave which will add to the measurement errors. As shown in Fig. 5, the gap between the probe and the slot wall is often packed with resistive material to aid in preventing slot waves and radiation in general.

Very often a microwave crystal rectifier is included in the probe carriage, together with a matching device to equate the impedance of the probe coaxial line with that of waveguide. Movement of the probe carriage along the slotted section is precisely

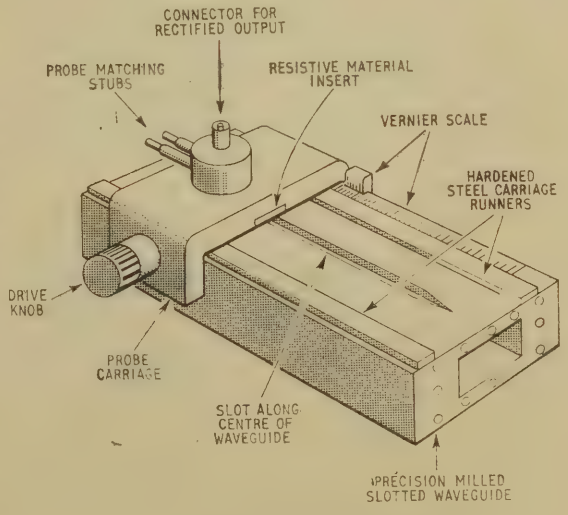


Fig. 5. Standing wave attenuator.

measured by the incorporation of a vernier scale, or a micrometer.

From the foregoing it will be appreciated that a good standing wave detector is a precision instrument, and as it is perhaps the most frequently used instrument in the microwave laboratory, will amply repay any additional care taken with it.

Wavemeters

As in low-frequency work a common requirement is the precise measurement of frequency. This can be accomplished at microwave frequencies by several methods. For example, the accurate measurement of the distance between two minima of a standing wave by a standing wave detector will give half the guide wavelength, from which the frequency may be easily calculated. This can, however, be rather tedious, and the usual method of measurement is with a wavemeter, or, as it is sometimes called, a frequency meter.

This device is quite simply a high "Q" resonant circuit. As mentioned in part three of this series, resonant circuits at microwave frequencies are obtained by the use of shorted lengths of line, either coaxial or waveguide. A half wavelength of line or any multiple thereof, shorted at both ends, will act as a parallel resonant circuit. For reasons that will not be covered here, circular waveguide cavities can be made to have extremely high "Q" factors, thus giving a very sharp resonance. This condition is of course ideal for a wavemeter, where high definition of frequency is required, and most waveguide wavemeters use this form of cavity.

The cavity itself is normally constructed from a highly polished silver-plated cylinder, made to very accurate dimensions. The frequency is varied by making one short circuit a variable plunger driven by an accurate micrometer type drive.

Wavemeters are normally made in two configurations. Perhaps the most frequently used is the absorption wavemeter. In this case the wavemeter is coupled directly from the side of a piece of waveguide forming part of the main circuit. Any signal at the frequency for which the wavemeter is tuned will be coupled into the wavemeter and absorbed, giving a sharp dip in the output. A line drawing of this type of wavemeter is shown as Fig. 6.

The main disadvantage of this type of wavemeter is that the sharpness of the dip is adversely affected by a high v.s.w.r. in the circuit, and as the power at the frequency of interest is absorbed, the device obviously cannot be left on tune in the circuit.

The other wavemeter configuration in general use

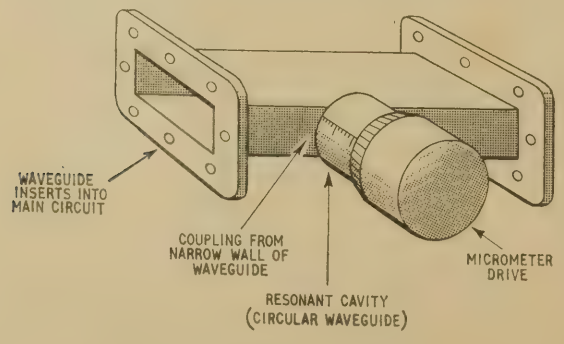

WAVEGUIDE INSERTS INTO MAIN CIRCUIT
COUPLING FROM NARROW WALL OF WAVEGUIDE
RESONANT CAVITY (CIRCULAR WAVEGUIDE)
MICROMETER DRIVE

Fig. 6. Absorption wavemeter.

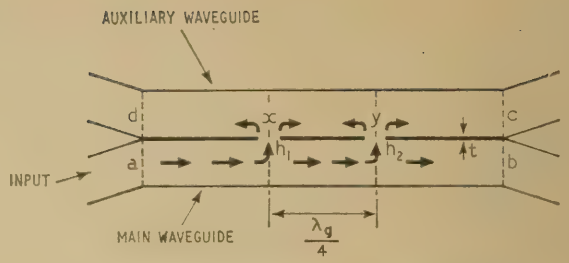


Fig. 7. Schematic diagram of a directional coupler.

is the reaction wavemeter. This device is coupled onto the end of a subsidiary waveguide line, and again absorbs some part of the signal to which it is tuned. Output is taken from the cavity by a probe in the side, that often incorporates a rectifying crystal, and thus provides a d.c. output when the wavemeter is tuned to the incoming frequency. The subsidiary line containing the wavemeter can be decoupled from the main waveguide by means of a directional coupler, as will be explained later. Standing waves in the main line will therefore have no effect on the wavemeter, which has the additional advantage of not affecting the output, so can be left in circuit to indicate any frequency drift. It has the disadvantage of requiring additional circuitry. All waveguide wavemeters can support an infinite number of modes, those supporting a harmonic of the wanted signal being obvious examples. The range of any wavemeter is therefore limited to avoid the ambiguity caused by these modes. In certain cases ingenious mode filters can be built into the cavity to suppress some of the unwanted modes.

Directional Couplers

In many microwave circuits it is required that a sample of the signal is taken from the main circuit. In most cases a portion of the signal from one direction only is required. This may be the incident wave, or the reflected wave depending on the circuit. This can be done quite simply by a device which is not normally used at low frequencies, the directional coupler.

Referring to Fig. 7, we have two waveguides with one broad wall common to both, and two identical holes in the common wall a quarter guide wavelength apart. Consider power fed into point (a). This will propagate down the main waveguide, and an amount proportional to the size of the holes and their position across the guide will be coupled through the holes h_1 and h_2 to excite the auxiliary guide, the remainder of the signal appearing at point (b). The power coupled through each hole will split equally, half travelling toward point (c) and half toward point (d). Consider now the waves and their relative phases at the reference planes x and y. If it is assumed that equal power is coupled through each hole, power will arrive at x from h_1 having travelled a distance $ah_1 + t$, and from h_2 having travelled a distance $ah_1 + \frac{\lambda_g}{4} + t + \frac{\lambda_g}{4}$. It will be seen that the path lengths are different by $\lambda_g/2$ or 180° and as the amplitude of each wave is equal, complete cancellation will take place. No power is therefore propagated in the auxiliary guide toward point (d). Consider next the reference point y. The path

length of the wave from h_1 will be $ah_1+t+\frac{\lambda_g}{4}$, whilst that from h_2 is the same and will be $ah_1+\frac{\lambda_g}{4}+t$. The two waves will be in phase and add all the power coupled through the holes propagating toward point (c).

If, as in the example above, point (a) is the input port, the arm of the auxiliary guide ending at point (c) is called the coupling arm, whilst that terminated by (d) is defined as the directional arm. It will be noted that if the wave direction in the main waveguide is reversed, the coupling and directional arms will also be reversed. Thus any output at point (c) will always, in an ideal coupler, originate at point (a), whilst any output at point (d) will always, in any ideal coupler, originate at point (b).

The main parameters of a directional coupler are *coupling* and *directivity*. Other parameters often quoted are main and auxiliary waveguide v.s.w.r. and power handling. Coupling is defined as the ratio of the input power to the power appearing at the coupling arm, when the remaining parts are terminated with a matched load. This parameter is usually quoted in decibels and is given by

$$C = 10 \log_{10} \frac{P_{in}}{P_{(c)}}$$

where P_{in} = input power (watts), $P_{(c)}$ = power at point (c) (watts), C = coupling (dB), and is proportional to the hole dimensions, positioning and number, waveguide dimensions and frequency.

Directivity is defined as the ratio of the power output of the coupling arm to the power output of the directional arm when the remaining arm is terminated with a matched load. Again the parameter is usually quoted in decibels being given by

$$D = 10 \log_{10} \frac{P_{(c)}}{P_{(d)}}$$

where $P_{(d)}$ = power at point (d), and D = directivity (dB). In the ideal case, as complete cancellation occurs in this direction, directivity is infinite. However, for various reasons this does not occur in practice, the normal limit being 50-60 dB.

There are many designs of directional couplers. The holes may be in the broad or narrow wall, round or a variety of other shapes, and the two waveguides may be parallel, at right angles, or at a specific angle dictated by the design. They are all based on the principle of waves adding in one direction and cancelling in the other. The directional coupler shown in Fig. 8 is a three-hole side-wall coupler, designed to act as an incident power monitor. It has a matched load built into its directional arm, the coupling arm having a mount for a rectifying crystal to measure the power in that arm. This is a typical application, and the performance, which is also typical, is coupling 20±0.5 dB, directivity 20 dB minimum, frequency 5950 Mc/s to 6450 Mc/s.

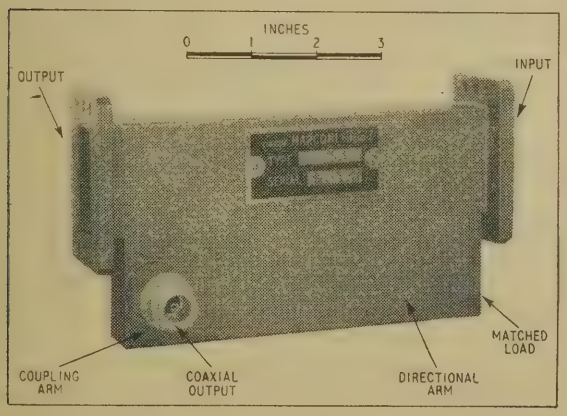


Fig. 8. Three-hole side-wall directional coupler.

Waveguide Loads

As has been mentioned previously, it is often necessary to terminate the end of a waveguide so that all the power is absorbed, and none reflected. It has been found that if the dimensions of the waveguide are changed very gradually, little reflection will occur. Simply tapering the waveguide to a point, however, will merely cause reflections from the point. If instead we insert into a short-circuited length of waveguide a tapered wedge of resistive material, reflections will be small due to the taper, and the power will be gradually absorbed by the resistive material. Any power remaining and reflected from the short circuit will again be greatly attenuated on its return path through the material. A diagram of this type of load is shown in Fig. 9.

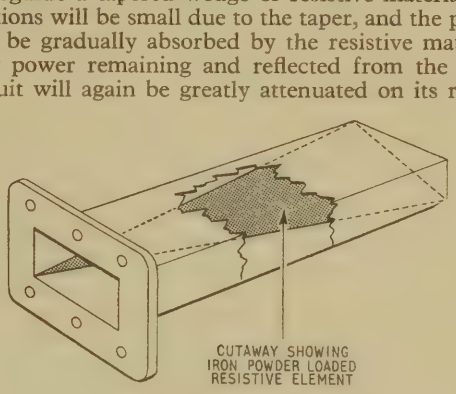


Fig. 9. Waveguide load.

The absorbing material is often a synthetic resin loaded with very fine particles of iron. The taper lengths are usually of the order of five times the guide wavelength, and the units are often finned to increase power dissipation. A standard load will have a v.s.w.r. of 1.01 or 1.02 to 1 over a waveguide bandwidth, although high-power components may have a mismatch as great as 1.15:1.

Waveguide-to-coaxial Transitions

As many microwave sources and outputs have coaxial feeders it is necessary to provide a transition between coaxial line and waveguide. For propagation to take place we must provide a suitable link between the field existing in the coaxial line and the field of the mode we wish to propagate in the waveguide. Propagation of the H_{10} mode, which we will consider here, is comparatively easy. A simple extension of the centre conductor of a coaxial line through the centre line of the broad wall of the guide is sufficient for narrow bandwidths. The length of penetration is made a quarter guide wavelength, whilst the waveguide is short circuited a quarter guide wavelength

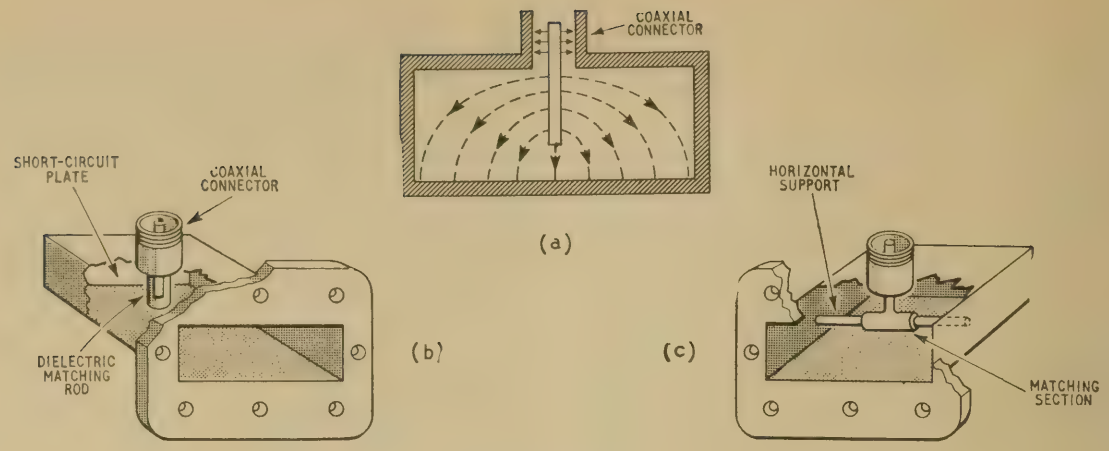


Fig. 10. Waveguide-to-coaxial transitions.

from the probe. A line drawing of this type of transition showing an approximate distribution of the electric field is shown as Fig. 10(a), Figs. 10(b) and 10(c) showing refinements of the basic technique giving a better match over a wider band.

Microwave Detectors

There are several methods of detecting microwave frequencies, but we shall concentrate on the commonest and possibly the simplest, the crystal diode. It has been found that one of the earliest of all detectors, the crystal and catswhisker, or to give it its modern name, the point contact diode, is ideal for the rectification of microwave frequencies. The crystal material is usually silicon and the diodes are normally made to a coaxial configuration for convenience in mounting. The characteristic is approximately square law over a fairly wide power range, but whenever possible should be operated at approximately constant power levels to ensure accuracy of measurements. The diode may be mounted in a coaxial line, which is attached to a waveguide to coaxial transition, or may be mounted directly in a waveguide, usually with a taper or some other form of impedance matching. A typical unit is shown as Fig. 11.

V.S.W.R. Indicator

The output obtained from our waveguide detector, whether it is an individual component, as just described, or part of a standing wave detector or other component, is at a very low level. For convenient use, particularly in measurement circuits, amplification is required. As stable d.c. amplification of low level signals is a rather expensive business, most microwave power sources intended for measurement work include square wave modulation at a few kilocycles. We can therefore use a high-gain, low-frequency amplifier with a meter output as an indicator in microwave measurements. As one of the primary uses of this indicator is the measurement of v.s.w.r., the scale is calibrated in this parameter, and the device called a v.s.w.r. indicator. Full-scale deflection is unity v.s.w.r., and the output obtained from the standing wave maximum is lined up with this reference. The standing wave detector probe is then moved to the minimum amplitude of the standing wave, the v.s.w.r. being read directly from the indicator scale. Modern v.s.w.r. indicators are designed to be quite versatile, and usually incorporate wide-range attenuators, power ratio scales, variable filters for various modulation frequencies, and many other useful additions.

In the next and final article in this series we will cover the more common microwave measurement techniques using the components just described.

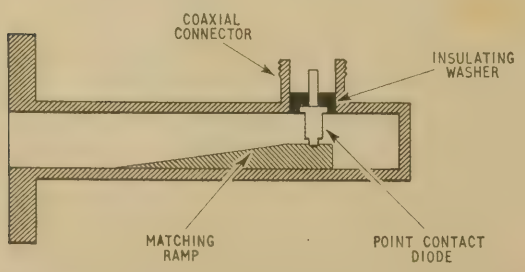


Fig. 11. Schematic drawing of a broad band crystal detector.

CLUB NEWS

Halifax.—A lecture-demonstration on transmitter alignment will be given to members of the Northern Heights Amateur Radio Society by L. M. Dougherty on November 25th. Fortnightly meetings are held at 7.30 at the Sportsman Inn, Ogden.

Heckmondwike.—Single-sideband operation will be discussed by A. W. Walmsley (G3ADQ) at the Spen Valley Amateur Radio Society meeting on November 26th at 7.30 at Heckmondwike Grammar School.

Ipswich.—Meetings of the Ipswich Radio Club are held on the last Wednesday of each month at 7.30 at the Civic College.

Loughton.—Peter Brooks, of the B.B.C., will talk about the Corporation's short-wave broadcasting techniques at the meeting of the Loughton & District Radio Society on November 6th at 7.30 at Loughton Hall, Debden Community Centre, Rectory Lane. The Society is collaborating with members of the British Amateur Television Club to present a closed-circuit television demonstration on behalf of the Television Viewers' Council at the hall during the period November 14th-21st.

Wellingborough.—The November meetings of the Wellingborough Radio Club, which meets each Thursday at 7.45 at Silver Street Club Room, include a lecture on electrochemistry by D. Slater (12th) and another on model aircraft and radio control by D. Britton (26th).

Television Distribution by Wire

2.–MAIN FEATURES OF A PRACTICAL H.F. SYSTEM

By R. I. KINROSS,* M.I.E.E.

IN this article it is only possible to concentrate on matters of general principle and a detailed description of all the items of equipment used in an h.f. system would be of little interest to the general reader. Nevertheless a very brief description of the more important items may not be out of place.

The system to be described is based on nine-pair cable of which six pairs can each carry one TV programme (vision plus sound) and three pairs can each carry one audio programme. (See Table 3.) Thus, during the next few years while we shall probably have only two B.B.C. plus two I.T.A. plus (possibly) one Pay-TV programme, the system will be capable of distributing five television programmes plus four sound programmes. When and if six television programmes have to be distributed, the sound programmes will be reduced to three if we stick to the straightforward principle of one audio channel per pair. However, it is quite feasible to distribute additional sound channels by means of phantom circuits (see Fig. 13) or by means of carrier channels. (Both these methods have been proved satisfactory in many towns.) These are not the most economical methods if 100% of subscribers were to require these extra channels since they require additional equipment in each home. The probability however, is that only a proportion of subscribers would require programmes such as stereo and in this case phantom or carrier would be the most economical overall solution.

Similarly as regards vision programmes on multi-pair systems it is undoubtedly most economical to devote one pair of wires entirely to each television signal, but there is no technical reason why two such signals should not be distributed on the same pair of wires. This has, in fact, been done on a system feeding several hundred thousand subscribers. There is no difficulty in manufacturing network transformers to cover the range 3-20 Mc/s. Thus, in the unlikely event of having to distribute more than six television programmes during the useful life of nine-pair cable, recently erected, additional programmes could be distributed using carriers of about 12 Mc/s and the problems associated with the separating and combining filters for this additional programme would not be anything like as formidable as those associated with separating and combining a total of seven television programmes on one coaxial cable.

Aerial Site:—Starting at the aerial site and assuming that the best possible aerials and low-noise amplifiers have been installed, we come to the system frequency generating equipment. In the days when only two 405-line programmes had to be distributed, frequency changers using crystal-controlled oscillators were used. The carrier output frequencies of these were at 5 and $8\frac{1}{2}$ Mc/s in order to produce the signals illustrated in Fig. 4. Subsequently, as more television programmes had to be distributed and exact synchronization between carriers became necessary, the outputs of these frequency changers were demodulated and re-modulated on a pair of ring modulators using a common crystal-controlled oscillator as a source of carrier. A more modern solution now becomes possible due to the method developed for reconstituting a colour sub-carrier from a short colour burst. It is now possible to remove most of the modulation from the signals emerging from a frequency changer by the use of a filter and limiter and feed the remaining signal to a comparator which compares its phase with that of another signal applied to it from a crystal-controlled oscillator. A d.c. signal proportional to the phase error is fed to a reactance valve which controls the frequency of the equipment producing the first signal. Several frequency changers can be controlled in this manner with the result that the signals which emerge have their carriers locked both as regards frequency and phase.

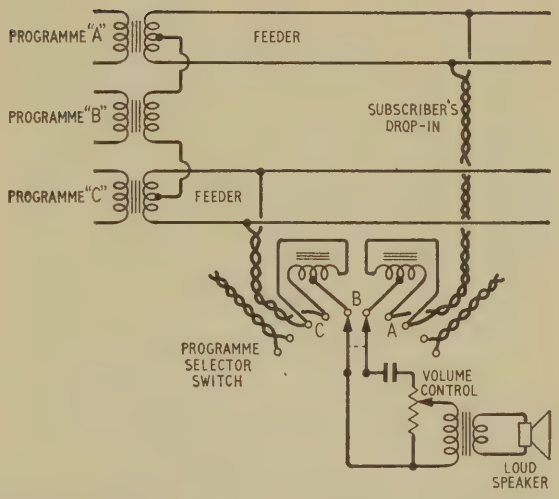


Fig. 13. Additional sound channels can be provided by phantom circuits.

A useful refinement at the aerial site is equipment for removing any distortion present in the received signal. This distortion can be due to the transmitting authority or P.O. lines or the receiving site or echos from distant buildings or hills. Considering the reception of a single pulse, most of this distortion can be boiled down to the presence of one or

*Rediffusion Research Ltd.

more unwanted pulses either preceding or following the main wanted pulse. These unwanted pulses may be opposite in direction or in the same direction as the wanted and will vary in amplitude. By designing an adjustable equalizer fitted with a number of delay lines it is possible to add to the received signal a number of pulses equal in amplitude but opposite in direction to the unwanted pulses and so appreciably improve the quality of the received signal. An example of such an improvement is shown in Fig 14. This same equalizer can also be used to introduce a certain amount of predistortion to compensate for the distortion normally present in a wired or aerial receiver due to vestigial sideband reception. Clearly it is more economical to correct the signal once for a town rather than build correctors into each of possibly 10,000 receivers used in the town. This adjustable equalizer is not, however, used for correcting distortion introduced by cable and repeaters: the method of dealing with this is described later.

Trunk Distribution System:—This is the name given to the network used for carrying the sound and vision signals with the least possible distortion from the aerial site (which may be some distance outside the town) to the various areas of the town to be covered. The main considerations for this network are minimum distortion rather than minimum cost, since trunk cables normally comprise only some 6% of the network as a whole. We therefore aim to connect as few repeaters in tandem as possible and to this end choose cable of low attenuation. We also wish to introduce no crossview whatever between signals prior to these reaching the cheap multi-pair feeder cables. Vision pairs should therefore be screened from each other and the natural choice in this case is multi-coaxial cable: one cable per vision programme. The audio programmes are usually distributed on balanced pair cables operating at voltages up to 650 volts a.c. and carrying kilowatts of direct audio power to the various distribution points. These distribution points are usually a mile to $1\frac{1}{2}$ miles apart and it is from these points that the feeders using multi-pair cable radiate outwards to subscribers. No subscribers are ever connected directly to a trunk system.

These trunk cables are undoubtedly bulky and expensive but the modern tendency is to run underground nearly all cables that do not feed subscribers directly. The cost of trenching and making good can be anything from 15s. to 30s. per yard so that cable costs tend to shrink in significance compared with this.

Repeaters have a gain of about 50 dB and are equipped with two outlets: one of $4\frac{1}{2}$ volts for continuing the trunk route and one of 15 volts for energizing the start of a feeder. A fault on a feeder causing a reflection back to the repeater will have no offect on the signal on the trunk route.

The trunk cable and repeaters introduce a small amount of group delay distortion and every second or third repeater this is corrected by introducing a few corrector units of the form shown in Fig. 15. The choice of corrector unit is very simple. A pulse and bar 6 modulated signal is transmitted down the trunk system and corrected for least distortion by adjusting a variable group delay corrector. This consists of a number of switchable filters as illustrated in Fig. 15 and is designed to introduce an adjustable amount of delay to $\frac{1}{2}$ Mc/s intervals over the band 4 to 11 Mc/s. The amount of delay introduced at each frequency is read from the pointers of the knobs which are directly calibrated in millimicroseconds and the appropriate fixed delay equalizers are then permanently connected.

Since the attenuation of cable in dB varies as $\sqrt{\text{frequency}}$, a frequency equalizer, whose value depends on the attenuation of the preceding cable section, is plugged into each tandem repeater.

Feeder Distribution System:—Since it is desirable to keep the number of repeater kiosks down to a minimum the trunk and feeder repeaters are usually combined as described above. Should it sometimes be necessary to start a feeder at some point other

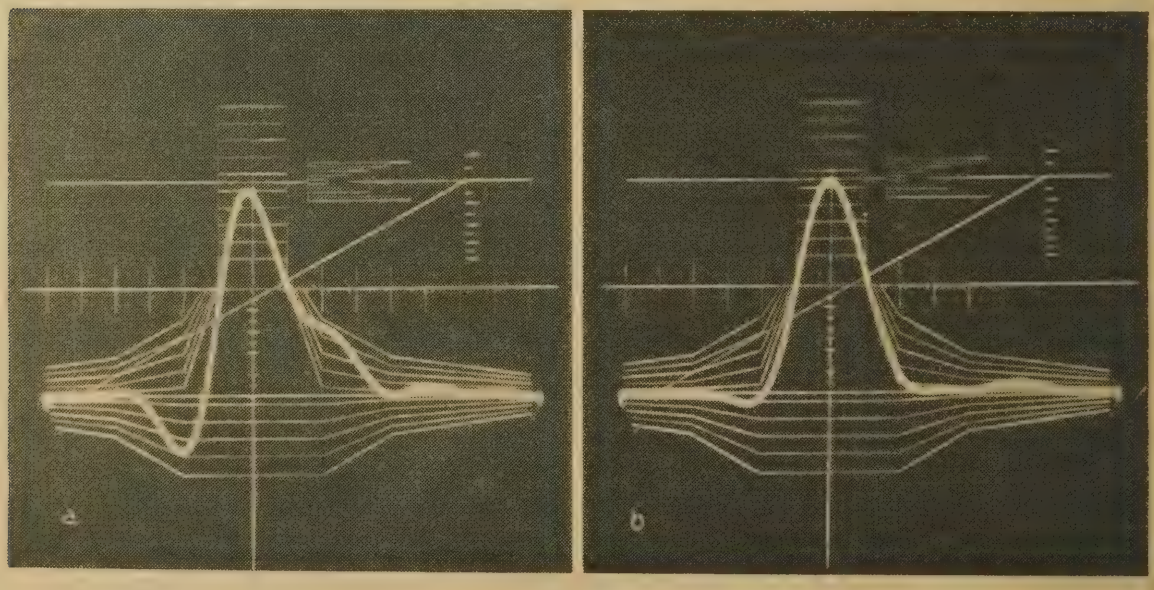


Fig. 14. Correction of pulse by means on an echo equaliser (a) before correction, (b) after correction.

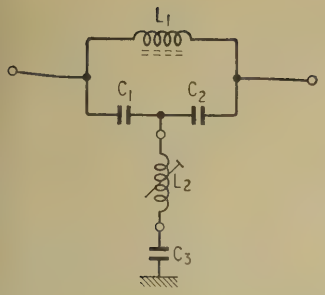


Fig. 15. Group delay corrector unit.

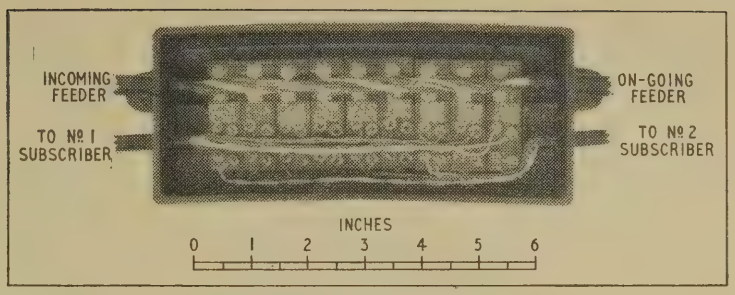


Fig. 16. Subscriber's junction box.

than at a trunk repeater, the input of a simple feeder repeater is bridged across the trunk cable. In theory a feeder repeater can energize some 20,000 yards of feeder but in practice, due to the fact that most feeder distribution areas contain parks, etc., 15,000 route yards is a normal useful coverage achieved. However, this compares very favourably with the figure of only some few hundred yards normally energized by a v.h.f. feeder repeater. Since the average amount of cable per house is some 10 to 15 yards the number of houses per h.f. repeater point vary from 1,000 to 1,500.

The foregoing refers to repeaters using valves capable of delivering some 15 volts of television signal to the start of the feeder. Occasionally it is necessary to feed small pockets of residential areas where it is not worth installing an amplifier of this type. In this case a small transistor amplifier is used, measuring 7in by $1\frac{1}{4}$in with a gain of 30 dB and an output of one volt. This is capable of energizing about 3,000 route yards of feeder. It requires no mains since it is energized by a nickel-cadmium battery, which is kept charged by means of a 50-volt supply fed to it over a phantom circuit using the feeders for this purpose.

The h.f. system, of course, requires a separate repeater for each programme, but since the number of repeater points on an h.f. system are usually 1/30th of those needed for a v.h.f. system, the total amount spent on repeaters is much less for an h.f. system.

The audio signals are stepped down from the trunk system to 55 volts by means of transformers.

The nine-pair cable, thus energized with vision and audio signals, is usually clipped under the eaves of houses where it is very inconspicuous, yet handy for the connection of a short drop-in cable to the subscriber.

Subscriber's Installation:—This consists of bridging transformers, a drop-in multi-pair cable, a programme selection switch and a wired receiver as illustrated in Figure 5.

It may be asked how it is possible to connect a subscriber quickly and economically on to all the pairs of cables that have been discussed. The solution lies in the design of a very cheap plastic junction box and the development of a method of connecting subscribers to the feeder spur in such a way that it is unnecessary to cut the spur cable or to bare the insulation of the spur cable. Thus the service is not cut off from subscribers receiving their programmes farther down the network and a subscriber can be connected to a multi-pair cable extremely quickly. A subscriber's junction box is illustrated in Fig. 16. Six of the inserts contain a high-frequency transformer which steps the vision voltage on the feeder spur down to a level suitable for the subscriber and at the same time presents an impedance across the feeder spur high enough to cause no reflection. It also transfers the audio signal directly to the subscriber as illustrated in Fig. 5. The remaining three inserts are straight through connections from the feeder spur to the subscriber drop-in and deal with audio signals only. Each of these subscriber inserts is capable of feeding two subscribers, but another version is capable of feeding four subscribers. It is thus possible to feed up to four subscribers with six television programmes and their sound plus a further three sound programmes from this junction box which overall measures 7in × 3in by 1in. The method of connecting the feeder insert to the spur without stripping the insulation of the latter is by means of sharp-toothed phosphor-bronze washers which are placed between the insert and the terminal screw head and these bite through the insulation of the feeder spur. Subscribers are connected by means of a pin and eyelet which strips the insulation from the drop-in wires as it is pushed on.

The programme selection switch consists only of a multi-way two-pole switch which can be made from a single standard switch wafer.

The wired receiver contains two h.f. pentodes for system frequency amplification and from then on follows conventional aerial receiver design. The sound is fed direct to the loudspeaker at 55 volts via a volume control and transformer. Thus the v.h.f. and u.h.f. turrets are eliminated as are also the complications of dealing with both a.m. and f.m. sound which is, of course, necessary on a 405/625 aerial receiver.

If a subscriber already owns an aerial receiver then an "inverter" is connected between the programme selector switch and the receiver. This converts the system frequencies into vacant channels in Band I or Band III. When the aerial receiver wears out and is due for renewal the subscriber finds he can buy or hire the simpler wired receiver for about two-thirds of the price of a new aerial receiver and usually does so. The inverter is then recovered and used in another home.

Colour:—Colour has so far only been mentioned in passing while considering such matters as crossview or changes in attenuation.

The availability of a multi-pair network clearly provides the engineer with many methods of distri-

buting colour information which are not available and could not be used for normal broadcasting. In broadcasting it is essential, whether the system used be PAL, SECAM or N.T.S.C., that the colour information should be contained within the bandwidth allotted to the transmitter for monochrome transmissions. The engineer responsible for designing a wired television system need have no such inhibitions if he feels that a simpler and cheaper overall system can be developed by transmitting the colour information outside the normal monochrome band.

However, to start with, the growth of colour television is likely to be fairly slow and it is important to make certain that signals distributed on networks can be satisfactorily received not only on special simple "wired" receivers but also on normal aerial receivers. Care has been taken, therefore, to ensure that all cable and repeaters installed on a wired system are capable of handling "in band" colour information such as that required for the N.T.S.C. system. In practice, providing care is taken over the linearity of repeaters and group delay correction is introduced in order to maintain a good monochrome picture no difficulty is experienced in distributing an N.T.S.C. type of signal in the h.f. band. These precautions add very little to the overall cost of the system. Later on, if it was thought that, for example, an "out of band" system would result in a material saving in the cost of the colour decoder in each receiver, the information for this could be distributed in addition to the "in band" colour information. This would, of course, slightly increase the cost of the repeaters on the system and would not be done until such a time as sufficient of a cheaper type of wired colour receiver could be connected to the network to warrant this additional extra expense.

Comparison Between H.F. and V.H.F. Systems Comparative Costs

There is undoubtedly room for the growth of both h.f. and v.h.f. systems but it is worth giving some consideration to the conditions which favour the use of one system rather than the other.

Let us start by listing all the items which will cost about the same for either type of system. These are:—

Aerial arrays, low-noise amplifiers, system origination equipment, wayleaves, feeder cable, cable fixings, feeder cable erection labour, trunk system (though the h.f. trunk system is more expensive per 100 yards there is less of it due to the fewer distribution points it has to feed.

The main items costing more for the v.h.f. system are the trunk and feeder repeaters. Usually thirty times as many repeater points are required so that even using broad-band repeaters for v.h.f. this means $7\frac{1}{2}$ times as many repeaters for a system distributing four television programmes.

The items which cost more for the h.f. system are:—

Audio amplifiers, subscribers' drop-in (more complicated junction box and the need for a programme selection switch), inverter (if required).

In a large town calculations show that most of the above differences cancel out and that there is very little difference in the cost of the two systems.

We are left, therefore, with the main point of the whole exercise, namely the difference in cost between a wired and an aerial receiver.

The latest figures obtainable on this are as follows:—

Average retail price including Purchase Tax of the cheapest models marketed under fifteen different brand names of 405/625-line 19in receivers equipped for u.h.f. reception. (Ref. *Wireless and Electrical Trader* Buyers' Guide, No. 9, 1963)	£70	0	0
Retail price including Purchase Tax of 19in Rediffusion Mark VIII wired receiver completely ready for 405 and 625-line programmes	£49	0	0
Difference	£21	0	0

This difference might be reduced by some £6 if a switchable aerial receiver is bought without a u.h.f. front-end since only v.h.f. is usually needed in a communal aerial system.

From the above it will be clear that in a block of flats in a town without an h.f. system or in an area so small that the number of v.h.f. repeaters is of little consequence, the choice may well be for a v.h.f. system. In a hotel, however, where the owner (as distinct from the owner of a block of flats) would be interested in owning or renting the cheaper wired receiver, the choice will almost certainly be for the h.f. system.

Of course, if the block of flats was in a town already wired for an h.f. system, the arguments are more evenly balanced. The owner wants to have *some* wired system to prevent the erection of private aerials, but he does not wish it to be thought that he is forcing his tenants to buy or hire a certain make of wired receiver. In fact he need have no qualms, since wired receivers are now being made by several manufacturers and marketed through normal retail channels.

It is interesting to note that in certain blocks of flats where both systems have been installed there is now a far greater number of subscribers on the h.f. system.

When introducing a wired television system to a town today, the fact that most of the inhabitants will already own a television set must at first sight appear to be a strong argument in favour of a v.h.f. system. However, the way in which owners of aerial receivers have eventually changed over to wired receivers in towns wired for h.f. a few years ago, coupled with the fact that a large proportion of aerial receivers in current use will not be able to receive B.B.C. 2, has encouraged h.f. system operators to continue introducing their systems into new towns.

With the advent of Pay TV it is perhaps worth mentioning a further point in favour of an h.f. system: the availability of its multi-pair cable considerably reduces the cost and complexity of the equipment needed to control the coin boxes or credit meters in subscribers' homes compared with what is required on a v.h.f. coaxial system.

The New Towns Commission recently decided, after considering very carefully the relative merits of h.f. and v.h.f. systems for Hemel Hempstead and Crawley, to adopt an h.f. system. Similarly the B.B.C. has decided to instal an h.f. rather than a v.h.f. system at the White City.

Acknowledgements.—Acknowledgements are due to the Directors of Rediffusion Limited for permission to publish this article, to cable manufacturers who have co-operated in the work of designing special cables and to the I.E.E. for permission to quote from two of the papers read to the International Television Conference in 1962.

The author would also like to thank his colleagues throughout the Rediffusion Group who have done so much to make the h.f. distribution system successful in large-scale operations.

Correction.—In Fig. 6 in the first part of this article (p. 499, October issue) the left-hand curve should be (c) and the right-hand curve (a).

REFERENCES

(1) Hollinghurst, F., and Hawkins, C. F. W.: "A Survey of the Development of Television Broadcast Relay in the United Kingdom," International Television Conference, I.E.E., 1962.

(2) Hooper-Smith, L. E.: "Wired Distribution Networks for Television at V.H.F., *Proc. Society of Relay Engineers*, Vol. V No. 5, Sept., 1961.

(3) Whitbread, C. F.: "V.H.F. Broadcast Relay Systems," *Proc. Society of Relay Engineers*, Vol. V No. 6, Dec., 1961.

(4) Hunt, G. J.: "Television Distribution by Coaxial Cable," *Proc. Society of Relay Engineers*, Vol. V No. 6, Dec., 1961.

(5) Whitbread, C. F.: "V.H.F. Broadcast Relay: Limitations to System Size," Contribution to International Television Conference, 1962.

(6) Lewis, N. W.: "Waveform Responses of TV Links," *Proc. I.E.E.* 1954 Pt. III, Vol. 101, No. 72, July, p. 258-270.

(7) Kinross, R. I.: "Television and Sound by Wire," *Wireless World*, 57, April, 1951, p. 126.

(8) Kinross, R. I.: "Distribution of Television by Wire," *Proc. Soc. Relay Engineers*, 1957, 4, No. 2.

(9) Hinchliffe, J. D. S.: "Recent Developments in Television Relay Cables," ibid., 1959, 5, No. 1.

(10) Bass, P.: "The Influence of Cable Characteristics on Wired Television," ibid., 1960, 5, No. 3.

(11) Osborne, B. W.: "Picture Quality Control Equipment for Wired Television Networks," ibid., 1961, 5, No. 4.

(12) Russell, K. A., and Sanchez, F.: "A Common Carrier Multi-Channel Television Wire Broadcasting System," *J. Brit. I.R.E.*, 1960, 20, p. 497.

(13) Hope, H.: "Investigation into the Operation of Television Transmitters with Carrier Frequency Precision Offset," *Rundfunktechnische Mitteilungen*, 1958, 2, p. 265.

(14) Adorian, P.: "Television Distribution by Wire," *Proc. I.E.E.*, Paper No. 1352 R, April, 1952 (99, Part IIIA, p. 665).

(15) Kinross, R. I., and Russell, K. A.: "H.F. Television Distribution Systems," Paper No. 4139E, presented at International Television Conference, 1962.

COMMERCIAL LITERATURE

Six more **planar epitaxial transistors** have been added to the SGS-Fairchild range. Data sheets on these semiconductors are available from the company's offices at 23 Stonefield Way, Ruislip, Middx. Transistor type 2N3304 is a high-speed device (700 Mc/s) for logic applications with 30 n/sec maximum storage time; 2N3209 is a 20V version of the 2N2894, which is a 550 Mc/s unit intended for fast switching and r.f./i.f. amplification; 2N3120 and 2N3121 are 45V versions of the 2N2927 and 2N2696 which are designed for use as either high-current switches or v.h.f. amplifiers; and 2N3072 and 2N3073 are 60V versions of the 2N3120 and 2N3121, which are also designed for use in v.h.f. amplifiers and high-current switching circuits.
14WW 301 for further details

A brochure describing the German Elac "Studio Series" of **transcription units** has been forwarded to us by the company's United Kingdom agents, The High Fidelity Centre, 61 Woking Street, Dorking, Surrey. Both of the units described are fitted with four-speed motors, and can be operated from any 220 V, 50 c/s or 115 V, 60 c/s supply.
14WW 302 for further details

Mullard Permanent Magnets is the title of a 20-page booklet available from Central Enquiry Handling, Mullard Ltd., Mullard House, Torrington Place, London, W.C.1. The introduction contains information on the properties, and the manufacturing proccesses of Magnadur, Ticonal and Reco magnets. Further sections of the booklet give information on general magnetic theory, applications of permanent magnets, magnetic circuit design, and a table of magnetic symbols.
14WW 303 for further details

Inductive, photoelectric and ultrasonic **proximity switching** is described in a leaflet available from Mec-Test Ltd., 218 Dover Road, Folkestone, Kent. Solid-state switching is featured. Details of their loop system, which is capable of sensing large masses of both ferrous and non-ferrous metals at distances from $\frac{1}{2}$ in to 36 in are given.
14WW 304 for further details

High Frequency Crystal Filters is the title of a 48-page brochure (MQ/108) describing 22 types of filters specially designed for use in mobile radio equipment, with either 12.5, 20, 25 or 50 kc/s channel spacing. Copies of this publication are available from the Quartz Crystal Division of Standard Telephones and Cables Ltd., Edinburgh Way, Harlow, Essex. The characteristics of each device are given in tabular and graphic form.
14WW 305 for further details

The Sophisticated Oscilloscope is the title of a six-page publication written by John Kobbe, manager of the advanced circuitry department of Tektronix Inc. (first published in *Industrial Research*, U.S.A., in March of this year). It briefly describes the evolution of the cathode ray oscilloscope and comments on the present-day limitations and recording facilities. Future developments are also discussed. Copies are available from Tektronix U.K. Ltd., Beaverton House, Station Approach, Harpenden, Herts.
14WW 306 for further details

Avo Transistor Manual.—The second edition of the Avo International Transistor Data Manual is now available, price 35s post free, from Avo Ltd., 92-96 Vauxhall Bridge Road, London, S.W.1. It contains information on approximately 5,200 transistors, and includes a number which are now obsolete. The products of some 90 transistor manufacturers and distributors' products are listed from countries all over the world. Names and addresses of the manufacturers are included, and, where known, the name and address of the United Kingdom subsidiary company or agent is given. A complete cross-reference between Commercial and Services Common Valve (CV) specifications is also included in this 217-page publication.

Leaflets describing the Series 433 **tape recorder counters,** whose features include push button reset, are available from English Numbering Machines Ltd., Queensway, Enfield, Middx. Three- and four-digit counters are described.
14WW 307 for further details

LETTERS TO THE EDITOR

The Editor does not necessarily endorse opinions expressed by his correspondents

Pulse-counter F.M. Receivers

MR. Spencer, in the October issue, is worried about the possible television interference which might be caused by a pulse-counter f.m. receiver such as I described in my letter in the September issue.

He is, of course, quite right to show such concern, and I, too, have been very much conscious of the problem.

Both the original Scroggie design (June 1956), and the more recent crystal-controlled transistor design, operate the local oscillator at about 30 Mc/s to avoid producing interference with the London 45 Mc/s television transmissions. However, I live in the Midlands, where Sutton Coldfield (61.75 Mc/s) is the relevant television transmission, and this is why I decided to operate the local oscillator at about 45 Mc/s. If the local oscillator had been at about 30 Mc/s, its second harmonic could cause interference with television reception, whereas, in this part of the country, 45 Mc/s and its harmonics would seem to be relatively harmless.

Thus, it seemed to me that, if the circuit was to be published, I really ought to produce two designs—a London model and a Provincial model. This is a further reason why, in the event, nothing at all got published!

I did, however, take reasonable care to keep the amount of local oscillator voltage reaching the aerial socket to a minimum, and a rough measurement showed that both the fundamental and the second harmonic were well under 1 mV r.m.s.

It is, perhaps, worth contemplating the fact that the amount of unwanted power radiated by a receiver of this type, which has been well designed, is unlikely to exceed a thousandth of a microwatt. Mr. Scroggie, on page 182 of the April 1958 issue, mentions "the complete absence of a single reported case of interference of any kind by this type of f.m. receiver." Nevertheless, such receivers are basically more likely to cause interference than those with the usual 10.7 Mc/s i.f., and should be designed with all the more care because of this.

My reason for not operating the local oscillator at about 90 Mc/s was mainly that this would have made the circuit more difficult to tune up; with an i.f. as low as 160 kc/s, the r.f. and local oscillator tuned circuits would differ in frequency by only a small fraction of 1%, and the inevitable slight coupling between them would make the tuning adjustments of these circuits undesirably interdependent.

The use of a double superhet was considered, but was rejected on the grounds that it lacked the attractive simplicity of the system finally adopted.

Great Malvern. P. J. BAXANDALL

Transistor Circuit Design

IN the September issue on page 436 in the part dealign with bypassing of the emitter resistor R_E, Mr. Hobbs states that the bypass capacitor is decoupling r_e, and because this is only 6Ω in his example then very large capacitances are necessary if adequate low-frequency performance is desired.

I feel that Mr. Hobbs has overlooked the fact that the statement is true only if the impedance of the base circuit is insignificant. Any practical circuit will have a source impedance of, typically, 2,000Ω feeding into the base, hence r_e will be effectively in series with this resistance, R_s, referred to the emitter circuit, i.e. R_s/β.

Taking Mr. Hobb's value for β as 50 means that the resistance to be decoupled is 46Ω. Thus only one-eighth approximately, of the capacitance Mr. Hobbs indicates would be required for a given low-frequency performance.

Page 145 of "The Junction Transistor," by E. Wolfendale, also covers this aspect of decoupling.

Gerrards Cross, Bucks. B. H. GROSE

The author replies:

Mr. Grose in his letter makes interesting comment, although following upon my heading "Example of a Voltage Amplifier" it was a voltage drive that was being considered. No doubt he has a cascade arrangement in mind where the collector of one stage is coupled to the base of the next and where the collector load forms the source impedance to the second stage. Taking a figure of 2,000Ω for the collector load, the reflected resistance at the emitter would, I agree, be 40Ω and the size of the decoupling capacitor could be made eight times smaller.

Mr. Grose's example is more aptly covered by the succeeding paragraph on page 436 (September issue) where, for a relatively large source resistance, the transistor is treated as a current amplifier with current gain β. I would again maintain that it is wisest not to allow β to influence the overall gain of an amplifier and would say that it often pays to leave the emitter undecoupled. There is a technique, shown in Fig. 4, page 521 of the October issue, using alternative series feedback and shunt feedback stages where an emitter is decoupled straight to a rail and yet the voltage gain is determined solely by resistor values.

Flexibility is perhaps a watchword in transistor circuit design and, in describing a voltage amplifier, I was attempting to be as general (and therefore as helpful?) as possible. That many people think principally in terms of cascade amplifiers with one collector coupled to the next base, I had overlooked.

One attendant drawback of using the source impedance as an element involved in the low-frequency time constant is that the reflected impedance at the emitter is dependent on the current gain β; the low-frequency roll-off will vary with selection of transistor. How much neater it is to place the resistance physically at the emitter. As manufacturers improve their β tolerances, our problems will diminish and the outlook for the future will be rosier.

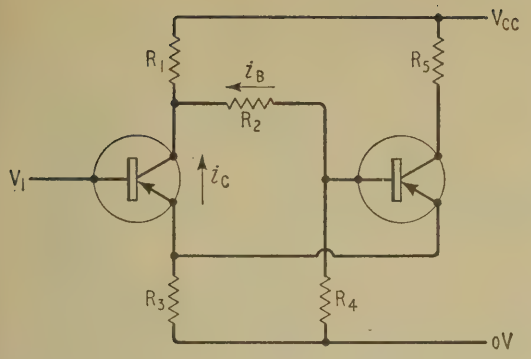
G. P. HOBBS

Trigger Circuit Design

IN his article of August, 1964, Mr. T. D. Towers touched on the basic design of the Schmitt trigger amplifier. With regret I note he has followed the all too common line of dealing with the circuit parameters "piecemeal," and referring those interested to other papers. Most of the literature tends to treat this simple circuit either as a design for the amateur magician (if you do not know, the writer prefers not to divulge!) or else quotes equations requiring a mathematical genius for analysis and solution.

Recently my work has required me to find a quick way to design such circuits capable of being built without undue dependence on device characteristics. Perhaps the method may interest others, as being free of the veil that often surrounds this circuit.

As a first step select the supply voltage V_{CC} to be at least ten times the voltage across the transistor $V_{CE(sat)}$



Take i_C (as value in data) for $\overline{h_{fe}}$. So that

$$R_3 = \frac{\overline{V_1} - V_{BE(sat)}}{i_C} \text{ and } R_5 = \frac{\overline{V_1}[V_{CC} - \overline{V_1} - V_{CE(sat)}]}{\overline{V_1} \cdot i_C}$$

Assume "i_B" $\approx \frac{i_C}{2}$ for initial calculation only.

$$R_2 = \frac{V_{CE(sat)}}{\text{"}i_B\text{"}} \text{ and } R_4 = \frac{\overline{V_1} - V_{BE(sat)}}{\text{"}i_B\text{"}}$$

$$\text{Hence } i_B = \frac{\overline{V_1} + V_{CE(sat)}}{R_2 + R_4}$$

$$\text{Giving } R_1 = \frac{V_{CC} - \overline{V_1} - V_{CE(sat)}}{i_C + i_B}$$

At this stage all resistors are specified for controlled backlash ($\triangle V_1$) and a check may be made of minimum gain required.

$$\underline{h_{fe}} = \frac{V_{CC} - \overline{V_1} - V_{CE(sat)}}{R_5\left[\frac{(V_C - \overline{V_1})}{R_1 + R_2} - \frac{\overline{V_1}}{R_4}\right]}$$

The design is not exhaustive but allows a clear circuit requiring little adjustment in practice, while each step is clear in itself to check on variations in one factor where this is required.

London, S.W.11. D. R. BILSTON

[The author's convention is to use bars to indicate levels above and below which the trigger will respond—Ed.]

Thévenin and Norton

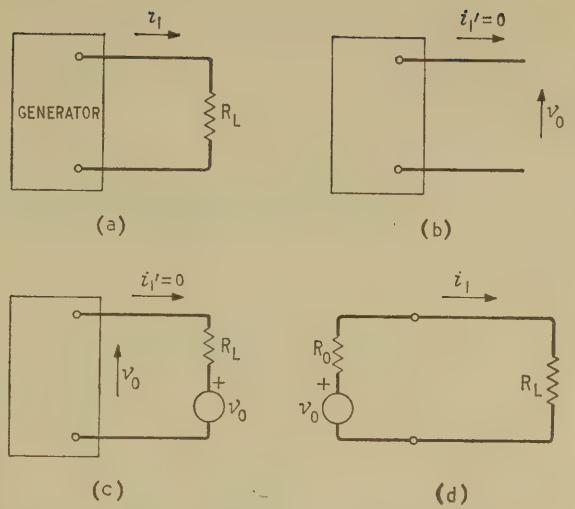
IN your January issue, "Cathode Ray" suggests the existence of a theorem which relates the power loss in a real generator to the power loss in its Thévenin (or Norton) equivalent. Such general relation can easily be shown to exist for purely resistive networks if one is allowed to dig up a little-known theorem due to Pomey (J.-B. Pomey: "Analogies Mécaniques de l'Electricité," Gauthier-Villars, 1921, pp. 50-51), according to which in any linear, lumped parameter and resistive network the sum of the products of the branch e.m.fs which determine a certain electrical state (I) of the network by the corresponding branch currents of a second state (II) is equal to the sum of the products of the branch currents of state (I) by the corresponding branch e.m.fs. of state (II).

The theorem suggested by "Cathode Ray" can be proved as follows:

Consider a generator (a) in the accompanying diagram, which contains only independent e.m.fs. of any waveform and ideal resistors. Let us consider for the time being the generator and its load as a single network having b branches numbered in such a way that the load (passive) branch, R_L, is branch No. 1. Let e_k and i_k be the series e.m.f. and current typical of branch No. k. State (I), corresponding to (a), will be given by the following array of branch e.m.fs. and currents:

$$\left.\begin{matrix} 0, & e_2, & \ldots\ldots\ldots & e_b \\ i_1, & i_2 & \ldots\ldots\ldots & i_b \end{matrix}\right\} \quad \text{(I)}$$

Since the network is purely resistive, the instantaneous



power, p_g, lost internally in the loaded generator will be given by the sum of the instantaneous powers supplied by the individual branch e.m.fs. less the instantaneous power dissipated at the load, i.e.:

$$p_g = e_2 i_2 + \ldots\ldots + e_b i_b - i_1^2 R_L \quad \ldots\ldots \quad (1)$$

If we disconnect the load, the new situation will be as pictured in (b), where v_0 is the open circuit voltage of the generator. As far as the branch currents are concerned, no change will be detected if we substitute the network represented in (c) for the one represented in (b). For (c) we have then the state (II) given as follows:

$$\left.\begin{matrix} -v_0, & e_2, & \ldots\ldots\ldots & e_b \\ 0, & i'_2, & \ldots\ldots\ldots & i'_b \end{matrix}\right\} \quad \text{(II)}$$

where i'_k represents the new value taken by branch current No. k in the generator network when its output terminals are open-circuited. Let p'_g be the instantaneous power loss in the generator under such condition. We have

$$p'_g = e_2 i'_2 + \ldots\ldots + e_b i'_b \quad \ldots\ldots \quad (2)$$

Referring now to (d), which shows the Thévenin equivalent of the real generator, let p''_g stand for the instantaneous power loss in the equivalent resistor, R_0, so that

$$p''_g = v_0 i_1 - i^2_1 R_L \quad \ldots\ldots \quad (3)$$

From (1) and (3) it is possible to write

$$p_g - p''_g = -v_0 i_1 + e_2 i_2 + \ldots\ldots + e_b i_b \quad \ldots\ldots \quad (4)$$

We now apply Pomey's theorem to states (I) and (II), thus obtaining

$$e_2 i'_2 + \ldots\ldots + e_b i'_b = -v_0 i_1 + e_2 i_2 + \ldots\ldots + e_b i_b \quad \ldots\ldots \quad (5)$$

By substitution in (4) we have

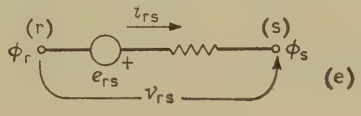
$$p_g - p''_g = e_2 i'_2 + \ldots\ldots + e_b i'_b, \quad \ldots\ldots \quad (6)$$

which, by comparison with (2) yields

$$p_g - p''_g = p'_g, \quad \ldots\ldots \quad (7)$$

which proves the following theorem: *The amount by which the instantaneous power loss in a purely resistive generator exceeds that in its Thévenin equivalent is constant with load resistance and equal to its instantaneous no-load loss.*

Of course, this theorem can be expressed in terms of the Norton equivalent. It would appear also that nothing fundamental in the proof given above would oppose the extension of it to networks with reactive elements provided the term "instantaneous power loss" is interpreted as the instantaneous power dissipated in the resistive elements plus the instantaneous rate of change of the energy stored in the inductive and capacitive elements.



The resistive case may be proved by reference to a typical branch joining nodes r and s, as shown in (e), let v_{rs} be the potential rise from r to s, and i_{rs} be the current flowing from r to s, for a certain excitation of the network; let v'_{rs} and i'_{rs} be the corresponding quantities for a second excitation of the given network. We shall first show that

$$\sum_{r,s} v_{rs}i'_{rs} = 0 = \sum_{r,s} v'_{rs}i_{rs} \quad . \quad .. \quad .. \quad .. \quad (8)$$

If ϕ_r and ϕ_s denote, respectively, the potentials of nodes r and s in the first state and ϕ'_r and ϕ_s represent the corresponding quantities in the second state, we can write

$$v_{rs}i'_{rs} = (\phi_s - \phi_r)\, i'_{rs}$$
$$v'_{rs}i_{rs} = (\phi'_s - \phi'_r)\, i_{rs} \quad .$$

Now

$$\sum_{r,s} v_{rs}i'_{rs} = \sum_{r,s} \phi_s i'_{rs} - \sum_{r,s} \phi_r i'_{rs}$$
$$= \sum_{s} \left[\phi_s \sum_{r} i'_{rs}\right] - \sum_{r} \left[\phi_r \sum_{s} i'_{rs}\right].$$

By Kirchhoff's current law, $\sum_{r} i'_{rs} = \sum_{s} i'_{rs} = 0$, so that $\sum_{r,s} v_{rs}i'_{rs} = 0$. By the same reasoning we get $\sum_{r,s} v'_{rs}i_{rs} = 0$.

All this shows that (8) is true, thus generalizing a theorem by Tellegen (cf.—G. Newstead: "General Circuit Theory," Methuen, 1959, pp. 30-31).

We now observe that

$$v_{rs} = e_{rs} - i_{rs}R_{rs}$$
$$v'_{rs} = e'_{rs} - i'_{rs}R_{rs} \quad .$$

By substituting in (8) we obtain

$$\sum_{r,s} (e_{rs} - i_{rs}R_{rs})\, i'_{rs} = \sum_{r,s} (e'_{rs} - i'_{rs}R_{rs})\, i_{rs} \quad .$$

Hence

$$\sum_{r,s} e_{rs}i'_{rs} - \sum_{r,s} e'_{rs}i_{rs} = \sum_{r,s} (i_{rs}i'_{rs} - i'_{rs}i_{rs})\, R_{rs} = 0\,,$$

which shows that Pomey's theorem is true for the resistive case, since the above implies

$$\sum_{r,s} e_{rs}i'_{rs} = \sum_{r,s} e'_{rs}i_{rs} \quad . \quad .. \quad .. \quad .. \quad (9)$$

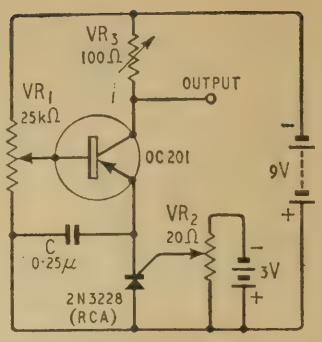
Cuba. J. ALTSHULER
Faculty of Technology, University of Havana

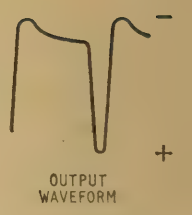
Thyristor Oscillator

ALTHOUGH there have been many articles describing the use of thyristors as protection elements in power supplies in your pages, their use in oscillator circuits seems to have been rather neglected. To remedy this, I would like to describe a circuit I have designed, using a thyristor, which produces an output waveform like that from a blocking oscillator, but with a sharper spike. The oscillator is self starting and does not require a blocking transformer.

The *modus operandi* is as follows. The initial conditions are such that the thyristor is in its high resistance state and the base potential of the transistor is set by VR_1 so that the transistor conducts thus charging capacitor C. The gate of the thyristor is biased from a low impedance source, i.e. VR_2, so that the thyristor "fires" and goes into its low resistance state before the transistor has been cut off by the rising emitter potential. The capacitor then discharges in two stages, thus producing a droop before the main discharge. The reason for this is not yet clear but is probably due to the transistor impedance at this stage in the cycle. As the capacitor undergoes its main discharge through the thyristor, the emitter potential of the transistor falls thus causing the transistor to conduct once again. At the same time the voltage across the thyristor has fallen to such an extent that the thyristor reverts back to its original high resistance state.

An output can be obtained by inserting a load resistance in the collector lead to the transistor. This resistance must be less than 80 ohms otherwise the circuit will not oscillate.





Frequency control is obtained by varying VR_1 and VR_2 within limits. This seems to have little effect on the width of the spike but alters the time interval between succesive spikes. Taking the base more negative and/or taking the gate more positive reduces this time thus causing an increase in frequency.

Applications of this circuit are numerous. By replacing the OC201 by a power transistor and the load resistor by a step-up transformer a d.c. to a.c. converter is possible. This would be very easily stabilized as a feedback voltage could alter the operating frequency directly. An e.h.t. generator would also be possible. Perhaps the most obvious application would be as a replacement to the blocking oscillator itself, thus doing away with one objectionable component, the transformer.

The device could also be used as a pulse code and possibly an f.m. modulator, the modulating voltage being applied to the base of the transistor.

Melton Mowbray. J. SLOMKOWSKI

Double Negative

IN your issue of September, 1964, I read a small joke article on page 447, entitled: "Ici on parle le double-talk," written by "Vector."

I have read this small insert with a smile. However, I do not think that "Vector" is conscious about putting the different levels of attenuators and amplifiers correctly. He is writing about an attenuator having a level of minus 12 dB, which I think is pushing very hard, because the whole article is dealing with a big noise around the visitor and if he adds an attenuator, having a rate of −12 dB, I would think that the whole level on the ear of the poor visitor will be very high, for, according to standard rules, negative numbers of dB markings are always amplified markings, whereas positive numbers are attenuated markings.

Due to the fact, that the denomination dB, as well as Np is by way of principle a logarithmic relation dealing only with fractions, that means:—attenuation. I suppose, however, that "Vector" is quite aware of this fact and this misplacing of negative and positive sign is part of a joke, or even part of a mistake, which slipped into his pen

Baar (ZG), Switzerland. O. STÜRZINGER

The author replies:

Herr Stürzinger is correct in his second supposition that the intrusive minus sign was a slip of the pen. I wish I could blame it on the typesetters but, alas, I find it appears on my original draft and was not properly corrected. The original sentence contained "−12 dB" in its correct sense, was subsequently crossed out and rewritten and the wretched expression sneaked in while I wasn't looking and exercised squatters' rights. It does at least prove (if proof be needed) the prophetic mettle of the Editor, who, in his commentary in the September issue wrote of this abashed contributor ". . . but we would not like to say that his sense of direction is always infallible."

"VECTOR"

Marconi Self-Tuning H.F System
—the first in the world to be station planned from input to output

breakthrough

MST 7½kW transmitter H1100 series

An h.f linear amplifier transmitter for high-grade telecommunications.
Frequency range: H1100 and H1101, 4—27.5 Mc/s
H1102 and H1103, 2—27.5 Mc/s
Output power: 7—8 kW p.e.p, 5—6 kW c.w.
The H1100 series meets all CCIR Recommendations.

saves 85% floor space

Transmitters can be mounted side by side and back to back or against a wall; built-in cooling fan; no external air-ducts. These features lead to smaller, simpler, cheaper buildings or more services in existing buildings.

simplicity

R.F circuits have only three tuning controls and two range switches. Final valve can be replaced in 30 seconds. Miniature circuit breakers (used instead of fuses throughout) can be reset instantly. All sub-assemblies are easily tested because they are electrically complete units.

rugged reliability

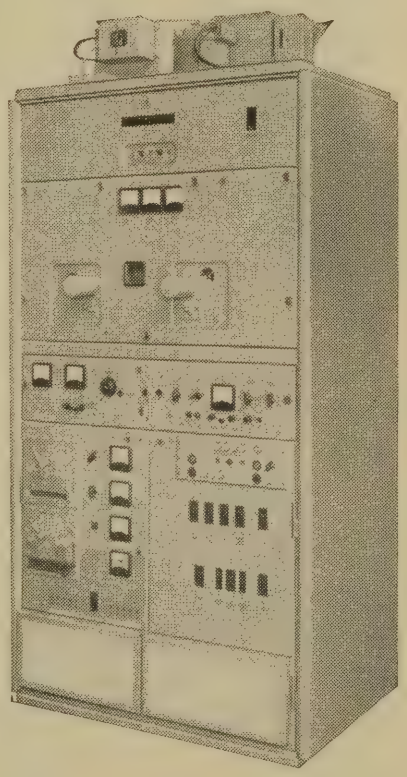
Stainless steel shafts in ball-bearings in rigid machined castings; stainless steel spur gears meshing with silicon bronze; heavy r.f coil contacts with high contact pressure—some examples of design features giving long term endurance and operational reliability. Specified performance achieved with ample margins.

self-tuning

Types H1101 and H1103, used with MST drive equipment, give *one-man* control of an entire transmitting station and continuous automatic aerial loading.

MANUAL TUNING

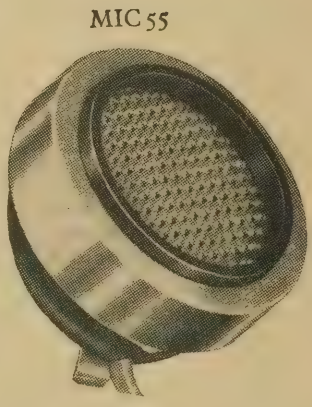
Manually tuned versions, types H1100 and H1102, are available which, when fitted with built-in drive units, become entirely self-contained transmitters for four spot frequencies and all types of modulation.
Manual tuning takes less than 60 seconds.

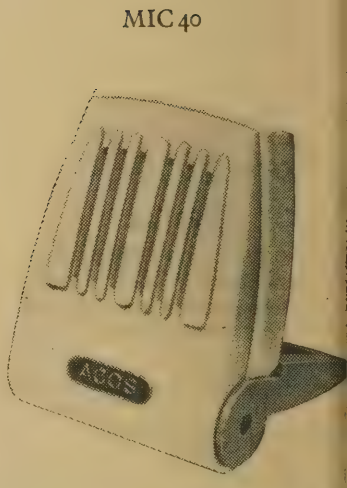


Marconi telecommunications systems

The Marconi Company Limited, Communications Division, Chelmsford, Essex, England LTD/H50

14WW—102 FOR FURTHER DETAILS.





Acos make the widest range of good microphones

Crystal, Ceramic, Dynamic, Magnetic

Acos have long been famous for their crystal technology. What is perhaps not yet generally known is that Acos make the finest range of microphones of *all* main types—crystal, ceramic, dynamic and magnetic. Each type has specific merits for particular applications and tape recorders. For instance:

MIC 39 Crystal and Dynamic. Quality microphones, handsomely styled. Both give excellent music reproduction. The MIC 39 Dynamic (moving coil) can use longer length of cable than crystal and is particularly suitable for transistorised recorders.

	Crystal	Ceramic	Dynamic	Magnetic
MIC 39				
MIC 40				
MIC 55				
MIC 60				

MIC 60 Crystal, Ceramic and Magnetic. Similar to MIC 39 but intended for popular, lower-cost recorders. Ceramic will withstand temperatures over 40°C. Even in England, inside a closed car or in direct sun, use a ceramic. Magnetic for small transistorised recorders.

MIC 55 A lapel microphone identical in performance to the MIC 60.

MIC 40 Crystal, Ceramic and Magnetic—an outstanding success story even by Acos standards. Crystal is inexpensive and good, the ideal choice for many general-purpose uses, and one of the most widely used microphones in the world. Ceramic, slightly more costly, suitable for higher temperatures. Magnetic for personal transistorised recorders and dictating machines.

Eleven Plus

Eleven Acos types—each of them top in its class and price range, as is proved by the fact that *millions* of Acos microphones are standard equipment in many famous makes of tape recorders. Acos microphones are readily obtainable as replacements. Often a new Acos microphone will improve the performance of a recorder. . .

acos *microphones*

STYLI, PICK-UPS, CARTRIDGES, MICROPHONES, EARPIECES, PRESSURE GAUGES, ACCESSORIES
Cosmocord Ltd · Eleanor Cross Road, Waltham Cross, Herts · *Telephone: WS 2733*

14WW—103 FOR FURTHER DETAILS.

COHERENCE

By "CATHODE RAY"

NOW that lasers are coming more and more into the forefront of our art, the words "coherent" and "incoherent" are inevitably heard. They are usually explained quite briefly, because their meaning is thought to be simple and there are so many much more involved matters to be covered in any treatise on lasers. In the hurry to get on to these, it may be that ideas about coherence are not always as coherent as they ought to be.

Although light and radio waves are identical except for frequency (as Hertz in 1884 went to great trouble to prove by experimental demonstration), technologically they were until recently quite different. Only the late "Free Grid" reminded us occasionally that in claiming a monopoly for signalling by wireless our Postmaster General logically should control such things as the winking lights on our motor cars. Even when television came in and radio engineers had to learn about light, it wasn't as an extension of their signalling waves to still shorter wavelengths, but as a new raw material for programmes, analogous to sound. The reason for this lack of interest in light as a solution of the frequency channel congestion problem was that all known sources produced what was, from a radio engineer's point of view, mere noise. In a word, it was incoherent.

Imagine how restricted radio and allied engineering would be if oscillators had never been invented! One just can, of course, signal with radio noise sources, such as sparks, as was in fact done in the pioneering days. But it is a crude business. Instead of a nice clean continuous carrier wave to work on, itself occupying practically no frequency-band width at all, it is already randomly modulated, so occupying an unpleasantly wide band. There is difficulty enough finding sufficient communication channels without that handicap. So although ordinary light *can* be used for signalling, as for example in lighthouses, or even modulated by speech ("talking over a beam of light"), its incoherent waves are unsuitable for anything much more refined than simple on/off modulation, which is fantastically inefficient as regards frequency-band utilization.

To see why light is incoherent we shall have to consider how it comes into existence. There is no such thing as continuous light waves, even in a laser. Light comes only in small bursts, called photons, which are emitted when atoms give up some of their energy. Although the words "atomic energy" conjure up ideas of devastating bombs or, at least, vast power stations, even the light from a burning match is energy given up by its atoms. Your ability to read these printed words is due to the fact that the atoms of paper, when stimulated by light, radiate energy over the whole visible range of frequency, whereas the atoms of printers' ink hardly do so at all.

It is the essence of the quantum theory, which came in with this century and is now firmly established, that energy cannot be infinitely divided, any more than matter. The amount of energy in each of its indivisible units (quanta) is directly proportional to the frequency of the waves by which it is radiated. So the range of quantum sizes is as enormous as the range of frequency; say from 10^4 c/s for very low radio frequencies to 10^{22} for cosmic rays. But they are all very small by ordinary standards because the relating factor—Planck's constant, h— is only 6.625×10^{-34} joule-sec:

$$\delta E = hf \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

Here δE denotes a quantum or least possible energy difference at frequency f c/s. If the energy of an atom fell by 4×10^{-19} joule, for example, this energy would be radiated as a photon at a frequency of $4\times10^{-19}/(6.6\times10^{-34})$—just over 600 MMc/s, which is interpreted by the eye as blue-green light. Fig. 1 shows the relationships between frequency, wavelength, colour and photon energy.

The ways in which atoms absorb and release

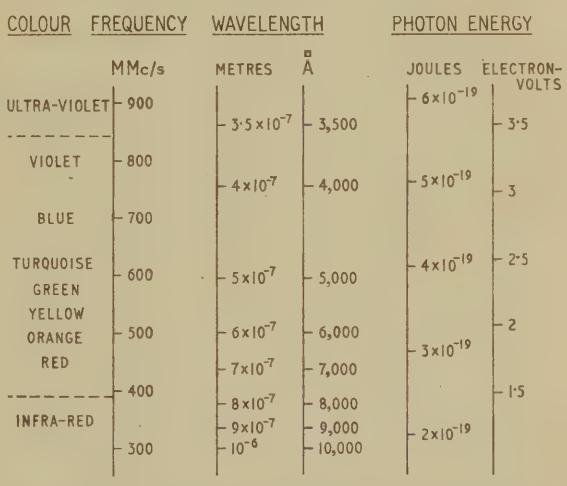


Fig. 1: Scales connecting colour, frequency, wavelength and photon energy of light. 1 angstrom (Å) = 10^{-10} metre.

photons are subject to strict quantum rules. For simplicity let us consider the hydrogen atom, which consists simply of one proton as nucleus and one electron, which can be regarded as a satellite of the nucleus. Just as more rocket energy must be applied to an earth satellite to put it into a higher orbit, so extra energy must be delivered to an electron to get it into an orbit farther from the nucleus. When an earth satellite descends because of gravity, some of its energy is given up; enough, in fact, to destroy it. When an electron "falls" towards the nucleus it gives up its energy as radiation. The vital difference, however—a result of the vast difference in scale between visible objects and electrons—is that an atom's electron must always be in one of a series of orbits or states, which are quite simply related to the series of whole num-

bers: 1, 2, 3, etc. The number 1 corresponds to the lowest or ground state, to which the electron gravitates when it is free from all outside influences, such as heat, light or electricity. When applied, these influences are capable of imparting energy and raising the electron to one of the higher states, from which it usually drops back at once, with release of the energy.

The biggest single energy step is from 1 to 2. When converted to frequency by equation (1) it turns out to be 2,469 MMc/s, far up in the ultra-violet band. This is more energetic than any visible light, which is incapable of raising hydrogen atoms from their ground state. However, an electric discharge through a tube of rarified hydrogen can do it.

Multiple Frequencies

Although an electron normally drops back too smartly for incoming radiation to catch it in an upper state and raise it farther, the drop-back is not necessarily to the ground state. For example, an electron raised to orbit 3 may drop to 2. The energy difference between 3 and 2 is several times smaller than between 3 and 1 or even 2 and 1; its frequency is 457 MMc/s, which is red light. There are many other possible frequencies, some of them still lower, in the infra-red.

Most atoms are relatively complicated and have many more possible electron states and therefore possible frequencies of radiation due to transitions from higher to lower. Furthermore, most atoms are united with other atoms to form molecules, and any changes in molecular structure involve energy differences. Some chemical changes yield products having more internal energy than before, so energy must be supplied to bring about such changes; for example, by applying heat. Particularly interesting are the chemical changes wrought in photographic film by brief exposure to light, which supplies the needed energy. Other chemical changes, such as those commonly known as burning, yield products with lower total internal energy, and we gratefully receive the surplus as heat and light. Changes within the nuclei of atoms provide energy much more intensely, but the general principle is the same. However, let us disregard nuclear sources of light, as fortunately rare, and confine our attention to emission of light due to electronic re-arrangements.

Atoms or molecules that are widely spaced, as in low-pressure gases, radiate on spot frequencies within the light band. But just as the natural frequency of a number of identical resonators spreads out into a band if the resonators are closely coupled together, so if atoms which have the same radiating frequency are brought close together (as in solids or even high-pressure gases) this frequency spreads out into a band. Metal filaments supplied electrically with heat energy provide light over the whole visible band, though more strongly at the red end, as photographers know. The sun, being at a higher temperature, fills out the blue end much better, giving a whiter light. White paper, exposed to white light, responds at practically all frequencies, so we get white re-radiation. Coloured materials are those whose molecules respond selectively to light of particular frequencies, like tuned circuits emphasizing particular frequencies present in "white noise."

From the foregoing brief summary of the science of light one might conclude that provided atoms were kept well apart, as in low-pressure gas, exciting them would yield light at exactly one or more spot frequencies, just as an unmodulated signal generator provides pure single-frequency radio-frequency waves. Even the fairly high-pressure sodium vapour discharge tubes used in many areas for street lighting give light on so narrow a waveband that it is seen as the characteristic yellow that so upsets complexions and other colour schemes. Although their bandwidth is certainly small in relation to their "carrier" frequency, by radio standards it is enormous. With the utmost care to confine energy changes to a particular transition in atoms too far apart to influence one another's radiation frequencies, the narrowest bandwidth is of the order of 400 Mc/s!

Even in proportion to the "carrier" frequency, this is at least several orders of magnitude worse than can be done with an unmodulated radio signal generator. One reason is the "granular" nature of light emission, by short bursts instead of continuously, as we have already noted. This is, in effect, modulation, with its inevitable sidebands. The

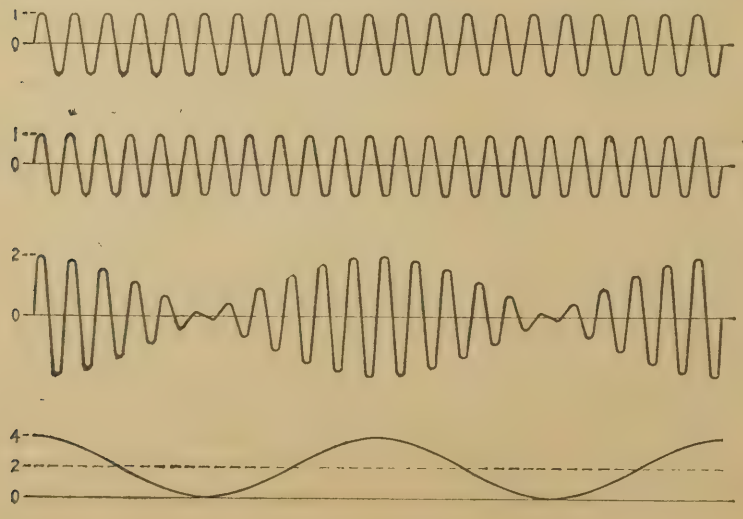


Fig. 2. Two wave-trains (a) and (b), of equal amplitude but slightly different frequency, add together to give a periodically varying ('beating') wave-train, (c). Its power varies as at (d) to give an average twice that of (a) or (b) alone.

shorter the wave-trains, the wider the band they occupy. Denoting the frequency spread by δf and the duration of each pulse of radiation by t, we have

$$\delta f \simeq \frac{1}{t} \quad \ldots\ldots\ldots\ldots\ldots (2)$$

If 400 Mc/s is taken as a figure for δf, t is of the order of $\frac{1}{4} \times 10^{-8}$ sec, so each photon comprises something like one million cycles (taking f as 400 MMc/s), totalling 75 cm. in a vacuum. In fact, however, only a minority of the observed band-spread is due to this cause, and the wave-trains are much longer—of the order of 3×10^{-8} sec., equal to more than 10^7 cycles, occupying perhaps 10 metres.

Doppler Shift

The major cause of band-spread is Doppler effect. We might not have expected this to come into the present subject, unless we happened to remember that photons are discharged from bases that are perpetually on the move owing to heat. In fact, one could say that this motion *is* heat. The drop in audio frequency due to the change in relative velocity between source and hearer when a racing car passes is familiar enough, so I hope there is not need to explain Doppler effect further. The higher the temperature, the faster the atoms or molecules move, and the greater are the Doppler shifts of frequency (above and below normal) in the light waves radiated. So I should mention that the 400 Mc/s band width cited above is typical at ordinary room temperature.

Because the wave-trains of light are emitted at completely random intervals, the phase relationships between them are random. Every momentary phase relationship between any two is equally likely. And because of the Doppler frequency differences the phase relationships go through every possible value continuously with time, as shown in Fig. 2, where (a) and (b) represent two simultaneous trains. These alternately reinforce and cancel one another, giving the combined result shown at (c). When there is full reinforcement (phase difference, 0°) the amplitude is twice that of one alone; when cancellation is complete (phase difference, 180°), zero. Halfway between, the difference is 90° and the resultant amplitude therefore $\sqrt{2}$ times of either alone. The average amplitude is obviously less than double that of each, but what counts is the *power*, which is proportional to the square of the amplitude. In the same three phase relationships it is, respectively, 4, 0 and 2; and the average (d) is 2, compared with 1 for a single wave-train. With n atoms or molecules the total power is of course n times that from one alone.

Fig. 2 shows how two wave-trains of slightly unequal frequency, which are observed at a fixed point, alternatively reinforce and cancel one another progressively with *time*. A very similar phenomenon called wave interference occurs in *space*. (This should not be confused with interference in its commonly used sense of intrusions spoiling one's broadcast programme.) Here the two wave-trains have the same frequency, and the phase differences are caused by differences in distance from the sources of the waves. And so one gets interference patterns, such as you can make by dropping two pebbles a short distance apart into still water. We radio people are familiar with this, because it is employed to obtain directional radiation, by assembling a number of wave sources (unit aerials) into an array devised so that their separate outputs reinforce one another in the desired direction and (as nearly as practicable) cancel everywhere else.

When we study light we are told that its waves, too, produce interference effects, which are often explained in the same way by showing two trains of sine waves interacting. Photographs of interference patterns are provided as evidence. Since light is to us a subsidiary subject that we have to pass at a modest level in order to be allowed to get on to radio engineering or the like, in our haste we can easily get the impression that interference of light is the same as interference of radio waves except for frequency, overlooking the fact that sources of light are incoherent. Sine waves in the diagrams are an excessive simplification, and consequently the phenomenon of light interference is much more restricted than in radio.

Once it has been grasped that light is incoherent, the wonder is not so much that interference ever fails as that it is ever possible. One might think that random noise, with its completely irregular and non-repeating waveform, could not show regular progressive phase displacements. And one would be right. But even white light is confined to a frequency band of about one octave (2 to 1 ratio), enormous though that may be to us in cycles per second. We have already seen that a band-width of 400 Mc/s (which in optics would be described as very monochromatic light) is so narrow at such frequencies that it does approximate to a sine-wave train over a considerable number of wavelengths. So light from a single source can interfere with itself by what in radio we call multi-path propagation. If the light is made to pass through two very small holes equidistant from the source, as in Fig. 3, each of the holes acts as a source of light having identical waveform, and interference patterns can be obtained.

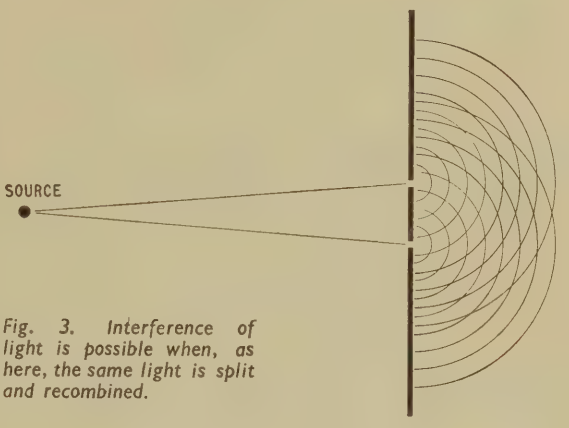


Fig. 3. Interference of light is possible when, as here, the same light is split and recombined.

Even so-called monochromatic light doesn't maintain its frequency constant enough to give clear interference effects with path differences exceeding a moderate number of centimetres, corresponding to time differences of the order of 10^{-10} sec. White light is obviously much more restricted still, but light of its constituent colours does interfere over a few wavelengths to produce the well-known colour

fringes that plague photographic transparency enthusiasts.

Light from independent sources, including different points on the same source, doesn't maintain even an approximately constant phase relationship at any one point, so interference effects are absent—a fact that is evidence of its incoherent nature.

White light, as we have just seen, is like "white noise" within an octave band, having no definite frequency; or all frequencies in that band, if you prefer to look at it that way. In a high-Q tuned circuit, random noise is selectively amplified, giving it a predominant frequency, just as white light can be made monochromatic (of one particular colour and frequency) by passing it through a suitable filter. By amplifying "monochromatic" radio noise and feeding a sufficient fraction of it back to the tuned circuit, the Q of the circuit can be made effectively infinite and we get a continuous wave-train of constant frequency. We call this device an oscillator. It should not be forgotten that oscillators work by amplifying the noise that inevitably exists in circuits.

Amplification and Oscillation

Until the invention of the laser there was no device for amplifying incoherent or "noise" light sufficiently to obtain coherent oscillation, even for brief periods of time. Even now, most of the several kinds of laser can yield only brief bursts of oscillation. I won't go into details of lasers, since these have been previously described*. It will suit our present purpose best to consider only the gas laser, which is capable of continuous output and phenomenally constant frequency.

In essence it consists of a tube of rarified gases, which are kept in a state of continuous excitation by a v.h.f. voltage applied between two electrodes. The effect is to put large numbers of the gas molecules into a state described as metastable; that is, one that lasts for what compared with a light-frequency cycle is a very long time (of the order of a millisecond) before dropping back and emitting light. However, those in this state drop back instantly if they are stimulated by light of exactly the frequency they emit. "Instantly" means instantly, so literally that the stimulated light falls into phase with the stimulating light. If you imagine a light wave, due to one molecule, sweeping along the tube, as it goes it recruits vast numbers of others which build up to a mighty army, all in step.

The ends of the tubes are designed to reflect something like 98% of the light, which about-turns and gathers more reinforcements from molecules that have been excited in the meantime. There is another reflection at the far end, which is spaced an exact number of half-wavelengths from the first, so that successive sweeps are all in phase. Light of that particular frequency and travelling along the tube is therefore strongly built up; light of other frequencies tends to cancel out, and light in other directions passes out of the tube at once instead of building up by multiple reflection.

Because reflection is not complete, some of the light emerges at one or both ends, and as the emissions of all the gas molecules are in phase, both in time and space, the output is coherent. That is to say, the separate waveforms not only coincide in time so as to reinforce one another; they are in the same phase along their whole front.

Although the similarity of this device to our electronic oscillators may not be obvious, both rely on feedback which is in such a phase as to reinforce an already existing oscillation, preventing it from dying out. And just as insufficient feedback coupling or excessive circuit losses prevent an oscillator from oscillating, so a laser will refuse to lase unless the reflected light waves are in the right phase and of sufficient intensity, and there are enough gas molecules in the metastable state.

As I said, gas lasers are by far the best for coherence, and with sufficient care in construction and operation can be made to provide light within a frequency band of about 1 c/s. Since the frequency is 4.74×10^{14} c/s, this means within better than 1 in 10^{14}! I have heard a recognizable beat note obtained by mixing the direct output from such a laser with a ray reflected from a surface moving towards or away from the source. To obtain a note of 1,000 c/s the relative motion needs to be at the rate of 500 wavelengths per second; that is to say, about one third of a millimetre per second! No wonder the beat note sounded slightly jittery, when every 0.0003 mm/s variation in this rate is enough to shift the frequency 1 c/s.

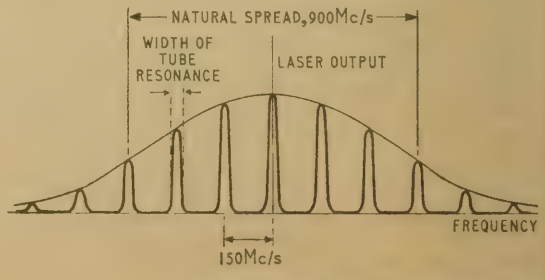
One can go on from this to deduce quite easily that the distance apart of the reflecting ends of the laser tube (normally 1 metre) has only to vary 0.0003 mm, or about one part in 3 million, to shift the output frequency 1 c/s. Hence the care in construction and operation mentioned above. For one thing, the temperature of the apparatus obviously has to be kept extremely constant. And the reflecting surfaces must be flat and parallel with truly optical accuracy.

It is interesting to consider the various steps by which the gas laser reduces the frequency bandwidth to such narrow limits as can be achieved.

First, the gas is at low pressure, so that broadening due to interaction of molecules is negligible. The main cause is Doppler effect caused by the molecules flying about at high speed. Owing to this and the quantum effect, their output is distributed over a band about 450 Mc/s each side of centre (which is 474 MMc/s).

Now, as we saw, the number of half-wavelengths between the reflecting surfaces must be a whole number if there is to be reinforcement by the reflected light. The wavelength at 474 MMc/s being about 6.33×10^{-7} metre, the number of half-wavelengths in 1 metre is about 3.16 million, so a shift

Fig. 4. Analysis of the frequency band of a gas laser.



*For example, by Aubrey Harris in *Wireless World*, Aug. and Sept. 1963.

of one half-wavelength is equivalent to a frequency shift of $(4.74\times^{14})/(3.16\times10^{6})$, or about 150 Mc/s. So there are several different wavelengths and frequencies, within the 900 Mc/s band generated by the gas molecules, that fulfil the regenerative requirement. They are represented by the peaks in Fig. 4.

These peaks represent the frequencies at which there is optical end-to-end resonance of the laser tube. Their very appreciable width indicates that the Q, although very high by radio standards, is not infinite, so without the regeneration of laser action there would not be continuous oscillation. This takes place at the peaks, of course, and a 1 c/s width (or even the considerably wider band of a less precise gas laser) is much too narrow to show on the same frequency scale. Oscillation can take place at more than one of these peaks, but there is unlikely to be sufficient overall gain for it to do so at the smaller ones.

Sensational figures have been published to the effect that the intensity of the light emitted from lasers is millions of times greater than that from the surface of the sun, which we imagine to be itself fantastic. And so it is, if radiation at all frequencies is counted, or even visible light frequencies only. But if we select the minute bandwidth covered by a laser, the sun's radiation amounts to only microwatts per sq. cm., or less! Obviously the total output of a laser cannot be large, because the input (on a continuous rating) is very modest, and the efficiency of gas lasers at least is very low because of their high selectivity. The intensity of light from lasers is remarkable only for its concentration within a phenomenally narrow band, which makes it quite different from ordinary light.

There is its directivity, for example. The beam from a gas laser diverges at an angle of about 0.5 minute, which means that at a distance of a mile it has spread out to the extent of only about 9 inches. In terms of the so much lower frequencies we use even in microwave radio, a laser is a beam aerial of enormous gain, able to project to distant points an intensity comparable with that at the generator. The interference effects which are relied on for beam aerial arrays are effective in lasers without the severe limitations that apply to incoherent light.

Incidentally, lest anyone continue in the popular error that the reputation of Einstein is built on relativity alone, it is worth mentioning that among his many prophetic achievements was the working out of the theory of stimulated light emission more than 40 years before the laser was invented!

CONGRESS ON MICROWAVE TUBES

PARIS, 14th-18th SEPTEMBER, 1964

THE 5th International Congress on Microwave Tubes was well attended, some 135 papers were presented. The papers were divided into three groups and continuous sessions were held in all three halls throughout the week. Clashes of interest were inevitable and frequent hurried walks between the quite widely separated lecture halls were an essential part of the conscientious delegate's day. In the circumstances it was rather unfortunate that the organizers decided not to do a pre-print of the papers.

However, the Congress as a whole was certainly worth while attending, for a large number of quite important papers was presented. As seems to be usual at conferences in Paris continuous translation facilities were available at the Ecole Polytechnique, and French, English and German speakers could present their papers in their own language knowing that their words and, what is perhaps even more important, the full contents of questions and answers at the end of each session would be immediately translated into the two other official languages of the conference.

The three groups into which the papers were divided were entitled "Low Power," "High Power" and "Advanced Studies." Each group was then further divided into a number of sub-groups.

Low Power: Forty-three papers divided into eight groups were devoted to low power microwave tubes. Eleven papers were given over to the subject of low noise tubes. The characteristics of electron beams and electron guns weer discussed in four papers. Eight papers on the subject of travelling wave tubes were presented and cyclotrons were discussed in another five papers. Klystron oscillators formed the subject of four papers and the remaining eleven papers were divided between magnetrons, carcinotrons and new structures.

K. Milne of the G.E.C. Hirst Research Centre described the problems met in the design of a wide-band travelling-wave tube for operation between 200 and 1000 Mc/s. The t.w.t. is attractive as a wide-band amplifier at these frequencies and if the helix voltage is sufficiently low a reasonable tube length can be obtained. Measurements of the dispersion of the interaction helix have shown that this and, not what might have been expected, the coupled helix couplers will be the limiting factor in obtaining wide-band performance. The tube designed by K. Milne has a bandwidth in excess of two octaves (from 250 Mc/s to 1000 Mc/s) and a noise figure of better than 7 dB. Typical values of gain are in excess of 20 dB and the saturated output powers are about 1 mW.

A transverse travelling-wave tube which holds promise of high efficiency has been operated at S-band at the Services Electronic Research Laboratories at Harlow. J. Carroll of that establishment said that the interaction is obtained between a slow cyclotron wave on a 7 kV beam and a transverse field slow wave on a meander line circuit. The basic theoretical efficiency of the amplifying mechanism is 75% in the tube that has been built. This is one reason for the high efficiency but, in addition, the electron beam carrying the cyclotron wave has no velocity modulation and can be expected to be used successfully with a depressed collector. Suitable collector depression can also recover the rotational power left on the cyclotron wave and increase further the theoretical limiting efficiency.

An interesting oscillator which utilizes a superconducting cavity, was described by Nguyen Tuong Viet of the Institut d'Electronique, Orsay. Such a cavity has a Q factor which exceeds 7 millions. When it is placed in the feedback path of a travelling-wave tube

amplifier which functions as an oscillator the microwave signal frequency obtained is very stable and can easily be set to the resonant frequency of the cavity. The author suggested that this could be used as a high Q factor measuring instrument.

Experimental techniques which have been devised at a wavelength of 1.8 mm for comparison of the relative advantages of confocal Fabry-Perot resonators to plane-parallel ones were described by A. P. Sheppard and J. W. Dees of the U.S. Army Research Office, Durham. They said that cavity resonators operating above 100 Gc/s pose severe problems due to the small physical size, and the Fabry-Perot interferometer offers an attractive possibility for overcoming these difficulties. With direct waveguide coupling into a semi-confocal Fabry-Perot interferometer of silvered plates a resonator Q of 90,000 has been observed.

Quite a number of interesting papers were devoted to carcinotrons, and this is a field in which the French have done a considerable amount of work, and in which they appear to be the leaders—at least in Europe.

High Power: Fifty papers divided into five groups were devoted to high power microwave sources. Seven French authors, all of whom were with C.S.F. presented papers on parasitic oscillations in high-power microwave tubes. Five papers were devoted to high-power travelling-wave tubes and electron guns and beams for high-power tubes were described in eight papers. No fewer than fifteen papers were devoted to high-power klystrons and an equal number of papers were given over to cross-field devices.

C. Enderby of the General Electric Co., Palo Alto, California described a new family of travelling-wave amplifiers which use ring-plane circuits which make possible high-power amplification at millimetre wavelengths. They are a variation of planar ladders in which the ladders are bent and placed together to form the ring-plane geometry. They have the high impedance and high heat-handling capability of ladder circuits and, in addition, they have a geometry which allows a solid cylindrical beam to utilize these advantages efficiently. An experimental tube constructed by Enderby produced 43 kW of power at 33 Gc/s. The low level gain of the tube was 20 dB and the tube operated at a voltage from 15 to 100 kV. The power output and efficiency ranged from 100 W at 4% to 43 kW at 12%. Instantaneous bandwidth was 300 Mc/s (1%).

A review of some recent advantages in high power klystron amplifiers was given by A. J. Prommer of Litton Electron Tube Corporation, San Carlos, California. He described a tube which, he said, was representative of the trend to higher average powers. This tube provided 5 MW peak power output and 300 kW average power output at L band. He said that the major problem areas on this programme were the generation, focusing and collection of an electron beam with an average power in excess of 1 MW, transmission of the 300 kW average power through the output window and beam control by a non-intercepting modulating anode at voltages up to 110 kV. In the field of high peak power development, he discussed the design of two 30 MW klystrons. Both klystrons are rated at 30 MW peak power and 30 kW average power with a 10-microsecond r.f. pulse length. One klystron works in the u.h.f. band and the other in L band. As an example of a high-mu modulating anode design, he described development work on a 10-MW hollow beam klystron. This klystron uses a magnetron injection gun, and utilization of the high gun perveance of this design has led to a low enough modulating anode voltage to allow the generation of beam pulses in the nanosecond region.

Advanced Studies: Forty-six papers divided into six sections were devoted to advanced work. Six papers were given over to electron optics. The generation, amplification and propagation of waves in plasmas were discussed in eight papers. Seven papers covered the field of electronic emission and particular emphasis was laid on laser applications. Thirteen papers were presented on the subject of interactions between electron beams and plasmas. Six papers were devoted to such subjects as electron cyclotron masers, tunnel lasers and optical masers using the negative glow of cold cathode discharges. The final six papers were devoted to new systems of generation.

A way round the difficult problem of designing coupling systems for millimetre beam plasma amplifiers was described by J. Allison and G. S. Kino of Stanford University. They used two counter-streaming electron beams in a caesium plasma. A system such as this has been suggested as the mechanism for certain types of radiation from the sun's corona. Allison and Kino constructed their tube to test this hypothesis and found that it also provided a useful amount of radiation at the second harmonic of the plasma resonant frequency. The plasma radiates directly and there is no need for any coupling device.

D. J. Blattner and his co-workers at R.C.A., Princeton, have developed an improved version of the travelling-wave photo-tube detector. They have inserted a transmission type photo-multiplier between the photo-cathode and the travelling-wave tube part of the standard detector. Their experimental tube was designed for a centre frequency of 1.5 Gc/s and has a bandwidth of 1.0 Gc/s. This new type of laser light detector combines the high noise-free gain of a secondary-emission multiplier with the very large bandwidth of a microwave helix.

M. A. Allen and C. S. Biechler of Microwave Associates Inc., Burlington, Mass., described experiments on beam-plasma amplifiers which gave output powers several orders of magnitude higher than any reported elsewhere. To date, output powers over 10 kW have been achieved at 3 Gc/s with efficiencies greater than 25%. Interaction bandwidths of 20% have been observed at gains greater than 30 dB. The tube uses a 20 kV, 2.8 A pulsed electron beam in conjunction with a hot cathode plasma injection gun discharge. An axial magnetic field is used to confine the plasma and focus the beam. The possibilities of increasing the power of this type of device to the megawatt average power range were discussed by the authors.

A very interesting way of obtaining the output from a semiconductor acoustic* amplifier was described by Dr. E. A. Ash of University College, London. He pointed out that one of the main obstacles that hinders the practical exploitation of the semiconductor acoustic amplifier is the difficulty of coupling to the drift-electron, acoustic-wave system. At microwave frequencies, particularly, coupling losses tend to be very large, even when using narrow-band resonant cavities. In his paper he described an output system in which the mechanical displacement in the semiconductors is used directly to modulate a beam of light. The end of the crystal forms one mirror of a two-mirror optical cavity. An unmodulated laser beam excites this cavity and the movement of the mirror results in amplitude modulation of the optical signal. This amplitude modulation can, if desired, be detected; but as Dr. Ash pointed out, there are many systems where an output in the form of an amplitude modulated optical signal would be a great advantage.

Conclusion: Details of only a few of the many interesting papers at this Conference are given here, and it would seem very well worth while obtaining the full volume of papers when they become available. (Dunod Editeur, 92, rue Bonaparte, Paris 6e.) At 230 francs—nearly £17—the price may seem a little high, but, for this, one would receive a very good review of current developments in the whole of the microwave field, including plasmas and quite a few papers on lasers.

* Involving vibrational energy, not necessarily audio—Ed.

Elements of Transistor Pulse Circuits

10.—COUNTER/TIMERS (FREQUENCY METERS)

By T. D. TOWERS,* M.B.E.

NOWADAYS, if you work in an electronics laboratory, you are expected to have some knowledge of counter-type frequency measuring instruments. These are steadily moving into the status of essential laboratory equipment—alongside the multimeter, the signal generator and the oscilloscope. Many basic pulse circuits discussed previously find a place in such counters, and looking at the working of a counter conveniently shows them in action.

Until the invention of the electronic counter, precise frequency measurements were carried out by comparing the unknown frequency with some accurately known variable standard, zero-beating the standard against the unknown. Heterodyne frequency measurements of this type tended to be slow, difficult, ambiguous and expensive. The electronic counter has changed this. It has placed within the reach of the average small laboratory equipment which is capable of measuring frequencies accurately to say seven or eight significant figures (e.g. to 1 cycle in 10 Mc/s), and yet of giving these precise results almost instantaneously, without ambiguity and with almost no manipulation of apparatus.

The basic principle of the electronic counter-timer is simply to count the number of cycles of an unknown frequency that occur in unit time. Fig. 91 illustrates this in block diagram form. To measure a frequency, the signal is fed into a gate as shown in Fig. 91(a). This gate is controlled by a timebase in the instrument, which arranges to open the gate for a precisely determined length of time, say 1 second. During the second that the gate is open, the input signal passes through and records on the counter the number of cycles passed in that second. The gate then closes and the number of cycles is left recorded and visually displayed on the counter readout. Thus we can read directly on the counter

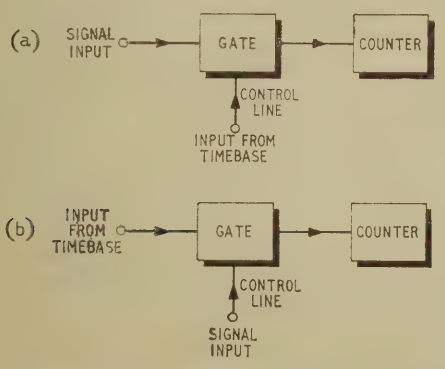


Fig. 91. Basic principle of counter/timer. (a) Measuring number or frequency (b) Measuring time or period.

the frequency of the input signal with the potential accuracy of the number of digits displayed. For example, with six-digit displays it is possible to count up to 999,999.

The same equipment can be used also to measure time or period, rather than number or frequency. To do this, it is arranged as in Fig. 91(b). Here the signal input is used to control the opening and shutting of the gate, and the input from the timebase is fed through to the counter. The signal input opens the gate for the duration of one period of the signal frequency. If the timebase is operating at say 1 Mc/s frequency, it will be supplying one pulse every microsecond into the gate. Thus there will be recorded on the counter the number of microsecond pulses passing through in one cycle of the signal input; the counter will then read in microseconds the period of the signal frequency.

We have illustrated the principle of the counter/timer in terms of a periodic signal input. However, it can be used equally well to measure the total number of impulses coming in on the signal input line (Fig. 91(a), even though they do not recur at a regular periodic rate. Similarly in the case of Fig. 91(b) the equipment can be used to measure the total time between two isolated events which are fed into the signal line, one opening the gate and the other closing it.

Typical Electronic Counter/Timer

Counter-timers (or digital frequency meters as they are sometimes called) in their commercial versions show many detailed differences of circuitry, but stripped of unessentials they all reduce in essence to the arrangement shown in block diagram form in Fig. 92. After the frequency to be measured has been fed into the input, the *input pulse shaper* amplifies the signal and converts the waveshape into the standard form of a square wave with very fast rise and fall times, suitable for driving an electronic counter. The shaped pulses are permitted to pass through the *signal gate* for such time as it is opened by the *gate control unit*. The whole system has been reset to zero before the beginning of the gate-open period so that the number of pulses passing through the signal gate are stored in total in the *counter*. The counter contents are recorded in visual numerical form in the *readout display*.

Thus far the gate control unit has performed two functions. It has reset the counter to zero, and opened the gate for the required gate period. The control of the gate period is effected from a timebase. This timebase comprises (a) *a master oscillator* which

*Newmarket Transistors Ltd.

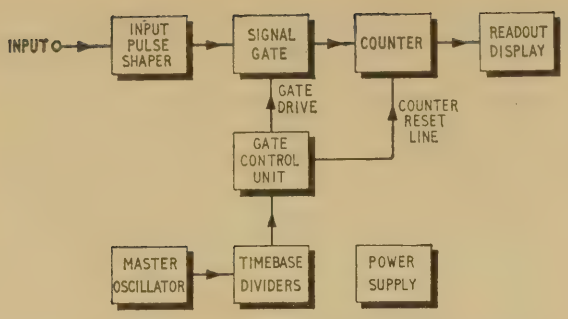


Fig. 92. Simplified diagram of typical electronic counter/timer.

is a stable crystal-controlled circuit and (b) a set of decade counter "times-ten" *dividers*, usually referred to as DCUs. The master oscillator itself is sinusoidal, but it includes a buffer squaring circuit which provides a timebase square wave of frequency f. The timebase DCUs provide derived square-wave outputs at frequencies $f/10$, $f/100$, $f/1{,}000$, etc. The operator selects the desired timebase frequency from those available and switches this manually into the gate control unit.

The *power supply* shown separately in Fig. 92 is the unit which supplies all the d.c. rail voltages to the other sections of the counter-timer. As it has no particular features of interest in the pulse circuitry aspect, we will not consider its detailed design. It is worth noting, however, that with the modern trend to transportable instruments for use independently of mains supplies, commercial units nowadays show a tendency to end up with a 12V supply which can be interchangeably provided by a car battery (for mobile work) or derived from the mains (for fixed station operation).

In the discussions of the previous paragraphs, we have considered that the gate has opened for only a single period of the timebase and closed again. However, if the unknown frequency varies with time, a single sample of this sort will not be satisfactory. The gate control unit has therefore to provide for successive repetitive sampling of the input signal so as to correct continuously the readout display of the frequency. This will be discussed in greater detail later.

Counter

The most important and probably the least understood section of a frequency meter is the *counter* itself. This usually comprises a counting chain of decade counter units arranged in cascade so that each one divides the output of the previous one by ten. Each DCU is a cascade of four binary counters. You can follow the build-up from the basic binaries to the complete counter in Fig. 93.

A typical basic *binary* element is illustrated in Fig. 93(a). This type of circuit has been discussed in some detail in previous articles in this series. It is a bistable multivibrator of the Eccles-Jordan type. Pulses fed into the input line are steered alternately to the two transistor bases in turn and cause the circuit to switch from the condition where the right-hand transistor is conducting to cut-off and back again. We take the condition with the right-hand transistor conducting as the "set" state of the binary and where it is cut off as the "unset" state. Every time the binary is driven to the set state a positive-going pulse appears at the output, and to the unset state a negative-going one. The reset line shown is normally shorted to the earth line, but, if it is disconnected from earth, the right-hand transistor is driven hard on through the 470 ohms and 6.8 kΩ connected from the negative rail to its base. Thus to reset the binary, all that is necessary is to open circuit the connection between the reset line and earth. The actual example of a binary given in Fig. 93(a) is capable of switching reliably at not less than 1 Mc/s.

The *decade counter unit* shown in diagrammatic form in Fig. 93(b) is an arrangement of four binaries with two feedback loops. The output of each binary feeds into the input of the next one. Each binary divides by two, so that the cascade of four would without feedback divide by sixteen, i.e., would give one output pulse for each sixteen that are fed into the input. To divide by ten, two feedback loops are inserted which cause the decade counter unit to skip altogether six counts. For every ten input pulses then, the DCU gives one output pulse. There are many ways of arranging feedback loops to convert a divide-by-sixteen into a divide-by-ten. The method of Fig. 93(b) is only one of the many possibilities. The output terminals marked "$_1$" "1," "$_2$," "2," etc., in Fig. 96(b) are taken from the collectors of the respective binaries. They are used to drive a separate *readout* display which shows numerically by some form of lamp or illuminated figure the actual number of counts stored in the DCU. These may vary from 0 to 9. When the contents of the DCU reach 10, it gives out a pulse and reads 0 again to carry on counting the next ten pulses.

The complete *counter* unit is made up of a cascaded series of DCUs as shown in Fig. 93(c), each one feeding its output into the input of the next one. The same number of DCUs are required as the number of digits required in the readout.

Readout Display

The *readout display* unit shown in the layout of Fig. 92 as fed from the counter can take many forms in practice, varying from a cheap meter for each digit place, up to very complex electroluminescent elements. Much ingenuity has been consumed in trying to produce a cheap reliable readout device, but with no great success so far. Most of the commercial readout units are expensive in themselves and also require an expensive decoding network to transform the binary information from the counters into a decimal display. Because there is little standardization in this field yet, we will not consider further here the decoder circuits, etc., required in a practical instrument.

Input Pulse Shaper

Logically the next element to be considered in the layout of Fig. 92 is the *input pulse shaper*. Fig. 94 gives a detailed circuit of a typical pulse shaper capable of operation up to 1 Mc/s and over. Here the input signal passes through a 4.7 kΩ resistor attenuator with a 10pF compensating shunt capacitor

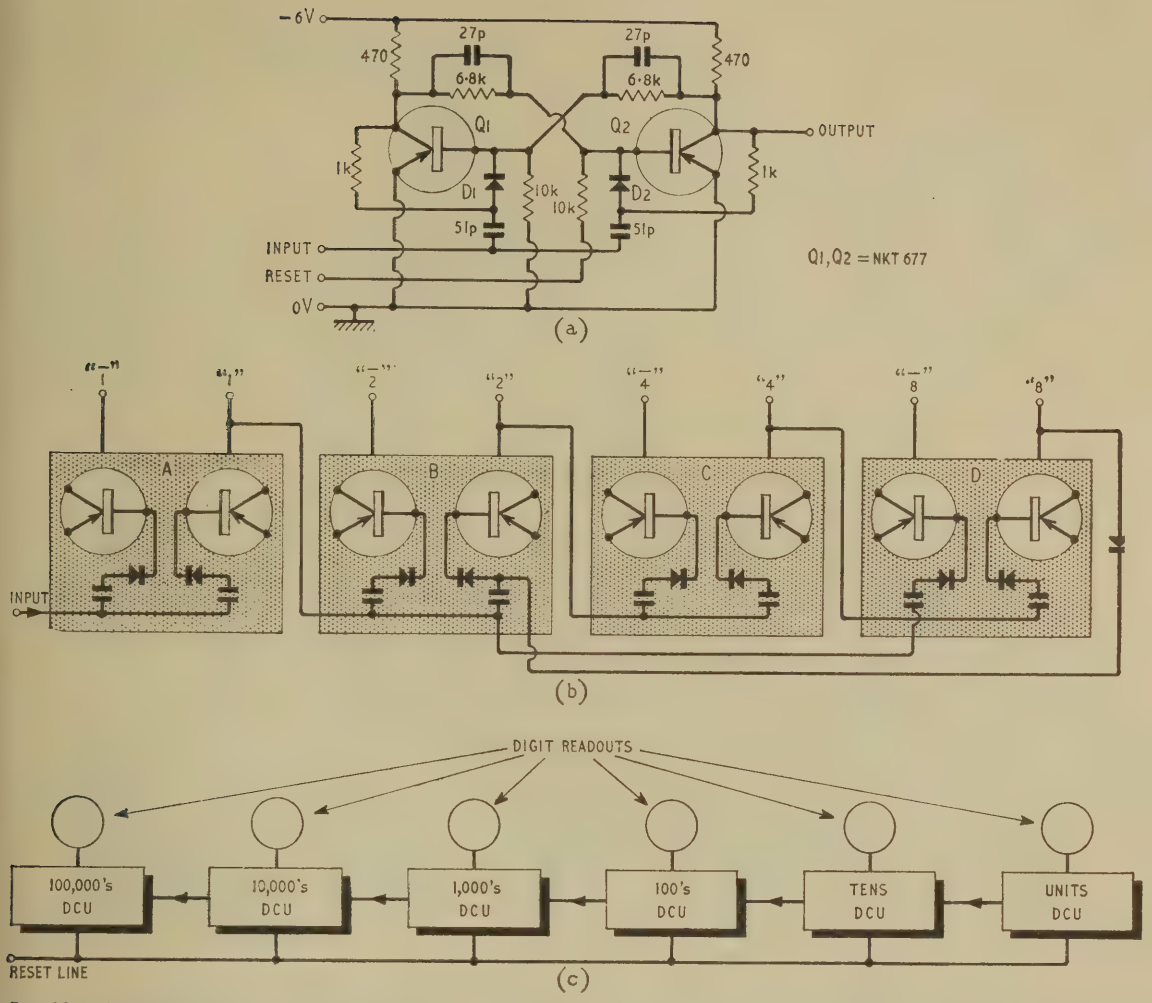


Fig. 93. Counter unit build-up. (a) Typical 1Mc/s binary (b) Four binaries connected as decade counter unit DCU (c) Six DCU's cascaded as six-digit counter.

for operation up to the highest frequency handled. At point A the signal is rectified by the diode D1 and the base-emitter diode of transistor Q1. After amplification through Q1, the signal reappears rectified at the collector as shown, i.e., in the form of a semi-sinusoidal pulse for each cycle of the input. Applied to the input of the Schmitt trigger Q2, Q3, the signal finally appears at the output of Q3 as a steep-sided square-wave pulse suitable for driving the counter circuits.

Bias to the base of the first transistor Q1 is provided from the 50 kΩ potentiometer across the −6 V, +3 V lines. By varying the setting of the slider on this potentiometer, it is possible to set the bias point of Q1 from full cut-off to full conduction. By this means we can adjust the setting of Q1 for optimum trigger sensitivity for any amplitude of input signal. In most commercial equipments the pulse shaper circuit is like the typical example given, i.e., a rectifying amplifier followed by a squaring Schmitt trigger.

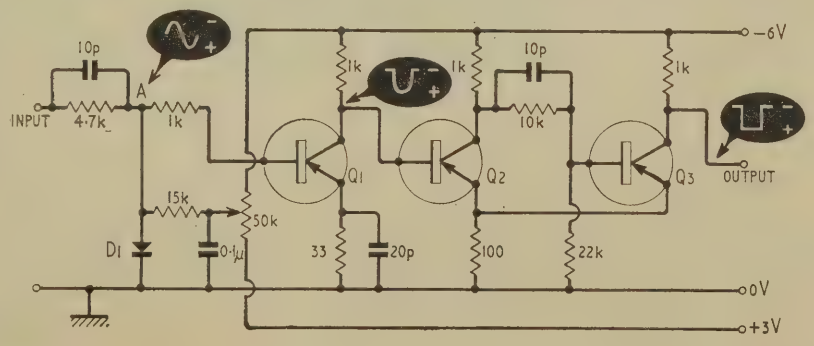
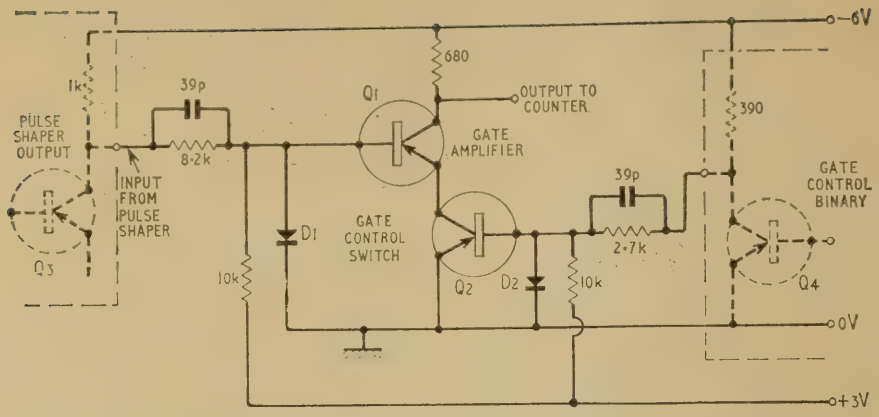


Fig. 94. Input pulse shaper (typical 1Mc/s circuit).

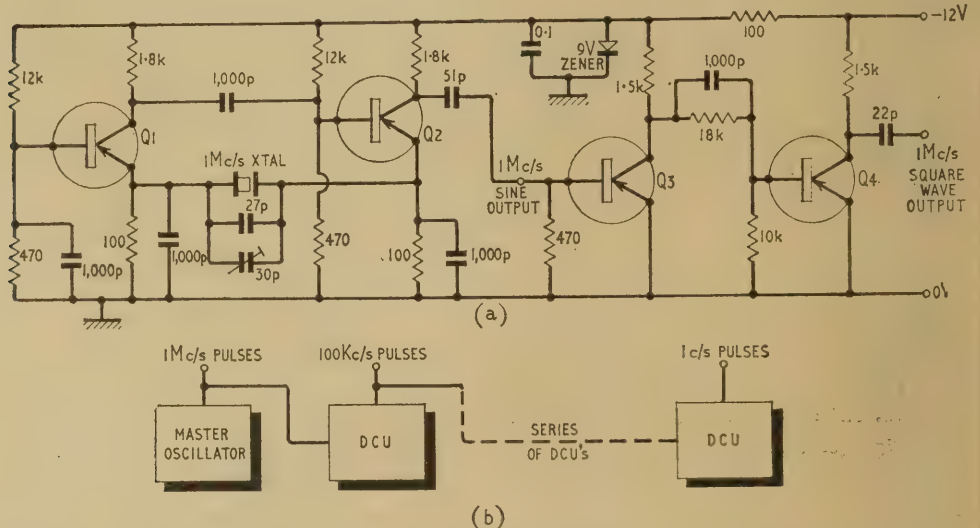
Signal Gate

The *signal gate* shown in block form in Fig. 92 as controlling the transfer of pulses from the input pulse shaper to the counter can take many forms, depend-

Left :—Fig. 95. Signal gate (typical 1Mc/s circuit).



Below :—Fig. 96. Timebase master oscillator and dividers (a) Typical 1Mc/s high stability master oscillator (b) DCU's used to provide range of timebase frequencies by repeated tens-division from 1Mc/s.



ing on the type of gate circuit favoured by the designer. Fig. 95 shows a typical circuit for this position. The output from the pulse shaper is fed via an 8.2 kΩ isolating resistor into the base of the transistor Q1. As before, the input signal is rectified by the diode D1 and the base-emitter diode of Q1. This rectified input waveform provides an amplified output unidirectional pulse at the collector of Q1. This gate amplifier can operate as a common emitter amplifier and thus pass a pulse through only if its emitter is effectively short-circuited to deck by the control gate switch transistor Q2 being bottomed (full on with a relatively low resistance from its collector to emitter). When the base of Q2 is negative the transistor is driven hard on and the gate amplifier can operate, i.e., the gate is open. Conversely, when the base of Q2 is positive, the transistor is cut off, and its collector presents a high impedance to the collector of Q1. This means that the gate is then closed.

The control voltage for the base of Q2 can be provided from the collector of the gate-control binary Q4, through a dropping resistor of 2.7kΩ and a 10kΩ resistor to the positive rail. When the gate control binary Q4 is cut off its collector rises close to −6V and the base of Q2 connected to the centre point of 2.7kΩ, 10kΩ attenuator from −6V to +3V is at a negative potential with respect to deck. Q2 is then switched hard on and the gate is open. Conversely it can be shown that, when the gate control binary Q4 is switched hard on, the collector is virtually at deck potential, and the base of Q2 is therefore positive. This cuts off Q2 and closes the gate.

Master Control Oscillator

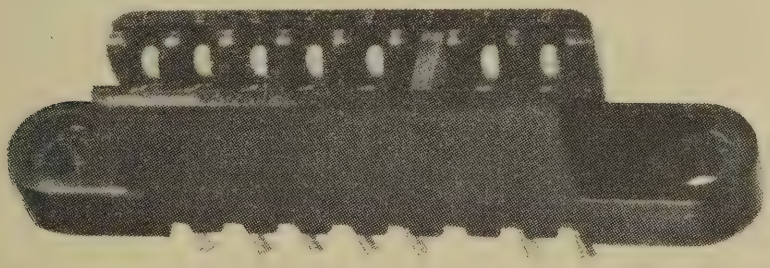
Considering the elements in Fig. 92 further, the next one to look at is the *master oscillator* unit. As mentioned earlier this is usually a crystal-controlled oscillator feeding into a squaring circuit unit. A typical 1Mc/s master oscillator circuit is given in Fig. 96(a). Q1 and Q2 form a Butler crystal oscillator circuit with positive feedback from the emitter of Q2 to the emitter of Q1 via the tuned circuit comprising the 1Mc/s crystal shunted by the fixed capacitance of 27pF and the variable 30pF. The variable capacitor is used for fine adjustment of the oscillator frequency. The 1000pF capacitors connected from the emitters of Q1 and Q2 to deck may look like decoupling capacitors across the 100Ω emitter resistors which would prevent the circuit oscillating. However, the decoupling is not complete because at 1Mc/s 1000pF has 150Ω impedance and the resultant impedances in the emitter circuits are not less than 60Ω each. The sinusoidal output of Q2 is taken via a 51pF into the base of the over-

(*Continued on page* 573)

Togetherness

Belling-Lee have ways of bringing circuits together, ways even more reliable and efficient than printed circuits themselves. Minimum size, maximum contact area, low contact resistance—these are all Belling-Lee features that result from extended research and development, and extreme precision in manufacture.

With 8, 12, 18 or 32 poles, printed circuit edge connectors mean easy insertion and interchanging of circuits in complex equipment.



Moulded guides can be used to assist insertion and rigidity. Other Belling-Lee printed circuit components include miniature single pole and coaxial sockets for jumper connections, and miniature fuseholders.

Remember

Poppy Day

BELLING-LEE

printed circuit components

For full details write to:

Belling & Lee Limited · Great Cambridge Road · Enfield · Middlesex · Enfield 5393

14WW—104 FOR FURTHER DETAILS.

Marconi self-tuning H.F system—
the first in the world to be station
planned from input to output.

MST

breakthrough

MST 30kW transmitter type H1200

An h.f linear amplifier transmitter for high-grade telecommunications.
Frequency range: 4-27.5 Mc/s.
Output power: 30 kW p.e.p, 20 kW c.w.
Meets all CCIR Recommendations.

saves 80% floor space

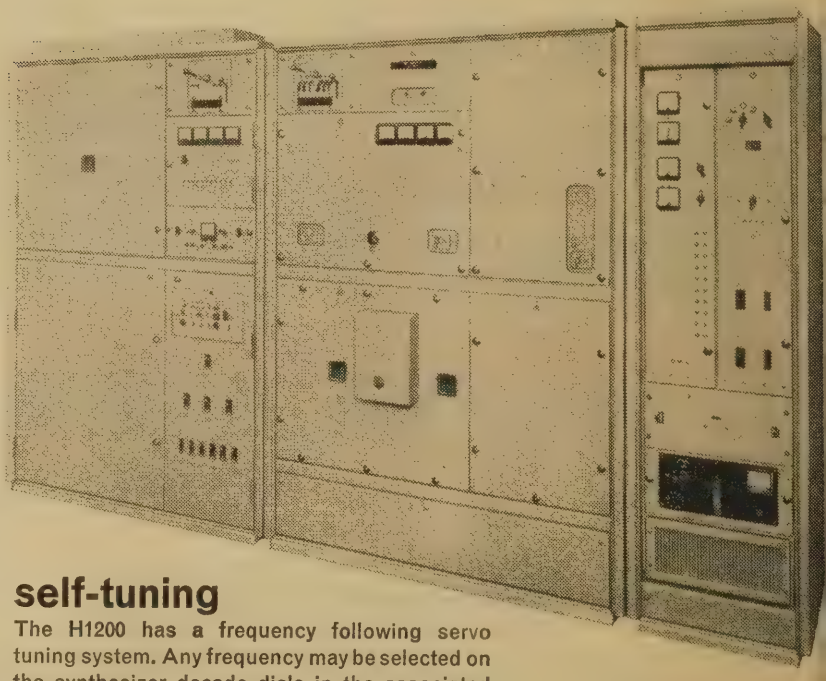
Transmitters can be mounted side by side and back to back or against a wall. Floor-ducts are eliminated and all power supply components are built-in. These features lead to smaller, simpler, cheaper buildings or more services in existing buildings.

rugged reliability

R.F circuits have been simplified and the number of mechanical parts reduced to a minimum. Highest engineering standards are applied to the design of these parts: stainless steel shafts in ball-bearings in heavy, rigid, machined castings; stainless steel spur gears meshing with silicon bronze; heavy r.f coil contacts with high contact pressure. Specified performance is maintained with ample margins.

simplicity

MST reliability allows continuous unattended operation with extended or remote control, saving maintenance and operating staff. Any fault in the servo control circuits can quickly be located with simple test routines. Transistors and printed wiring give these circuits maximum reliability.



self-tuning

The H1200 has a frequency following servo tuning system. Any frequency may be selected on the synthesizer decade dials in the associated MST drive equipment; the unattended transmitter automatically tunes itself in an average time of twenty seconds. Final stage tuning and loading servos continuously ensure automatic compensation for changes in aerial feeder impedance caused by weather conditions. Self-tuning gives *one-man* control of an entire transmitting station.

Marconi telecommunications systems

The Marconi Company Limited, Communications Division, Chelmsford, Essex, England LTD/HF

14WW—105 FOR FURTHER DETAILS.

driven amplifier Q3 followed by a further d.c. coupled amplifier Q4, which between them square off the sine wave input and give a 1Mc/s square wave output from the collector of Q4. To achieve high oscillator stability, the crystal is normally mounted in a constant-temperature oven. For stabilization against supply voltage changes, the d.c. supply to the two oscillator transistors is provided from a 9V Zener-stabilized rail as shown in the diagram.

Timebase Dividers

The master oscillator by itself can provide only a 1μsec gate time, and to deal with lower frequency input signals outputs at 100kc/s, 10kc/s, etc., down to 1c/s are normally required to provide gate times of 10μsec, 100μsec, etc., up to 1 second. The *timebase dividers* section of Fig. 92 is usually arranged as shown in Fig. 96(b). Here the master oscillator square-wave output at 1Mc/s is fed into the first DCU, which divides by ten and gives a 100kc/s square-wave output. This again is fed into a further string of DCUs, each of which in turn divides by ten. The outputs from these dividers provide trains of square waves at decade intervals down to 1c/s. Any of these can be selected for controlling the open time of the signal gate.

Control Unit

We now come in Fig. 92 to the logical heart of the frequency meter, the gate *control unit*. This is the most complex part of the equipment aid in Fig. 97 is set out in diagrammatic form the control unit of a typical counter to use as an illustration of how it works. Designs may differ in detail from Fig. 97 but all follow pretty much this pattern. The control unit is designed primarily to control the signal gate shown dotted at the top of the diagram, and its operations are controlled partly by the output from the timebase shown coming in on the left of the diagram. To illustrate the operation, let us assume to start with that the signal gate is closed. Let us also assume that the various binaries have all been reset in the control unit and the counter.

The first pulse from the timebase arriving at the open timebase gate passes through to the gate control binary and flips it over. The flipped binary feeds a d.c. signal through the signal buffer amplifier to open the signal gate. This lets the stream of signal pulses start feeding into the counter. The next timebase pulse arriving still finds the timebase gate open and flips the gate control binary back to its original state. This cuts off the d.c. control voltage to the signal gate and closes it. The stream of signal pulses to the counter is cut off, and the counter holds and displays the number of pulses that it has received while the gate was open.

In flipping back to its original "set" state, the gate control binary sends a positive pulse to the latch binary which causes it in turn to flip over. In flipping over, the latch binary sends a negative d.c. voltage to the latch buffer amplifier inverter. This voltage is inverted in the latch buffer and appears as a positive voltage to close the timebase gate so that further timebase pulses are inhibited (prevented passing through into the system) until the gate can be reopened.

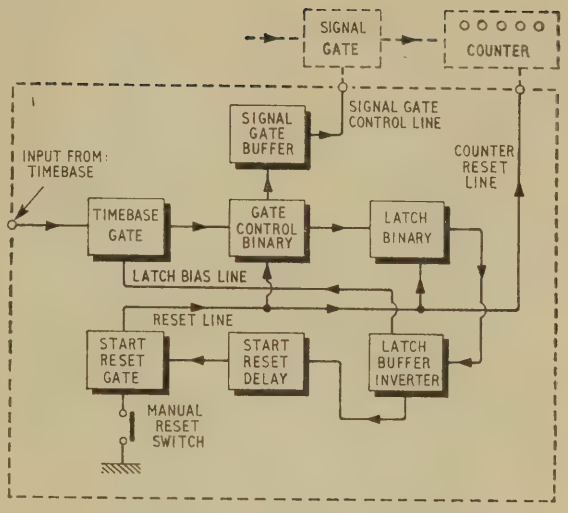


Fig. 97. Control unit of counter timer.

If we want the counter/timer to sample the input signal repetitively we must arrange for the whole system to be automatically reset to the initial state to let the cycle repeat again and again. This is achieved by using the same positive d.c. voltage shift from the latch buffer inverter that was used to close the timebase gate also to trigger off the start reset delay unit in Fig. 97. This circuit is a pulse delay unit which emits an output pulse at a predetermined interval after it receives the input pulse. The delayed output pulse from the start reset delay is used to open-circuit the start reset gate in the reset line. The opening of the start reset gate removes the earth connection of the reset line and resets the latch binary and the DCUs in the counter. In being reset, the latch binary emits a negative d.c. voltage level change which (inverted through the latch buffer inverter to a positive d.c. voltage level change) opens the timebase gate once again and lets the counting cycle repeat "from scratch." As the start reset delay circuit is arranged to respond only to a positive going pulse, it is not affected by this output from the latch buffer inverter.

Besides the automatic start reset provided by the start reset delay circuit, equipments usually include some form of manual reset switch as shown in Fig. 97. This is normally closed, but can be open-circuited manually to reset the whole counter ready to start counting.

The complete operation of the control unit may seem rather complex at first sight, but careful following through of the logic will soon show how the various circuit blocks work together.

Buffer Amplifier and Inverter

Before we go on to consider the start reset delay circuit in detail, we will first take a look at how the two *buffer amplifiers* in Fig. 97 work.

The *signal gate buffer* amplifier is an emitter follower of the type illustrated in basic form in Fig. 98(a). The output is in phase with the input, so that the negative output voltage from the gate control binary is transmitted to the signal gate also as a negative voltage, suitable for opening the gate.

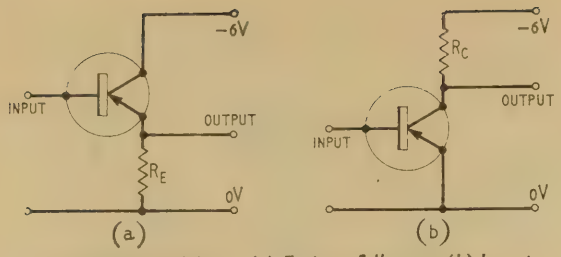


Fig. 98. Buffer amplifiers. (a) Emitter follower. (b) Inverter.

The *latch buffer inverter* in Fig. 97, on the other hand, is a common emitter amplifier of the type shown in Fig. 98(b) which inverts the phase of the input signal and provides from the negative input voltage fed to it from the latch binary the necessary output positive voltage to trigger on the start reset delay circuit.

Start Reset Delay

This brings us finally to detailed consideration of the last remaining circuit in Fig. 97, i.e., the *start reset delay* circuit. This is usually some form of monostable, and generally it is a multivibrator. Fig. 99 gives the circuit of a typical example to illustrate the design points. Q1 and Q4 together form a monostable multivibrator, with resistive cross-coupling from collector to base in one direction and capacitor cross-coupling in the other. The collector of Q4 is cross-coupled to the base of Q1 via the 3.3kΩ resistor. The 1,000pF capacitor across the 3.3kΩ is merely a speed-up capacitor, negligible compared with the resistor. The capacitor cross-coupling from the collector of Q1 to the opposite base is via the emitter follower isolating transistor Q2 through the 50μF coupling capacitor to the base of Q3. Q3 and Q4 form a Darlington pair equivalent to a single very high gain transistor.

The circuit operates roughly as follows. In the quiescent condition, the transistor Q4 is switched hard on by the 6.8Ω, 470kΩ and variable 250kΩ network to the negative supply rail. When a positive pulse comes in from the latch binary, it passes through the diode D1 and the 100pF capacitor to the base of Q4. This switches transistor Q4 off and Q1 on. A negative-going pulse appears at the collector of Q4 and is transmitted through the output coupling capacitor to the base of the start reset gate switch transistor Q5. Now Q5 is normally held switched hard on by the bias network of resistors to its base, and the additional negative pulse merely drives it harder on. Q5 thus remains fully bottomed, keeping the reset line shorted to deck.

During the quasi-stable state of the monostable, the 50μF capacitor discharges steadily with a time-constant set by the variable network of resistors connected to its right-hand end. Eventually, at a time determined by the setting of the 250kΩ variable resistor, the monostable flips back to its stable condition. When this happens, a positive pulse appears at the collector of Q4, is transmitted to the base of Q5 and cuts that transistor off for a short time. This open-circuits the reset line from deck and causes all the binaries in the control unit and the DCUs in the counter to be reset.

When the latch binary is reset in Fig. 97 the negative voltage on its output disappears and similarly the positive inverted voltage at the output of the latch buffer inverter which has been holding the timebase gate closed also disappears. Thus the timebase gate is reopened.

The whole system is thus reset ready to start as before, and the next input pulse from the timebase triggers off the counting cycle once again. The repetition time between sample counts is set by the 250kΩ variable resistor control on the start reset delay unit. In a practical instrument the recycling time is normally variable between a small fraction of a second and some tens of seconds.

Summary

In this article we have attempted to set out the main operational features of a typical counter-type frequency meter as a demonstration of uses of some of the basic elementary pulse circuits dealt with in previous articles in the series. In the space available it has not been possible to go into all the possible circuit variations likely to be met with in a commercial counter/timer, but most counter/timers work very much along the main lines indicated above.

[The final article in this series will appear in our next issue. We have received many applications for back issues containing earlier articles in this series, but many of these are already out of print. However, arrangements are being made to re-issue the whole series in book form in the New Year and the publication date will be announced as soon as it is known.]

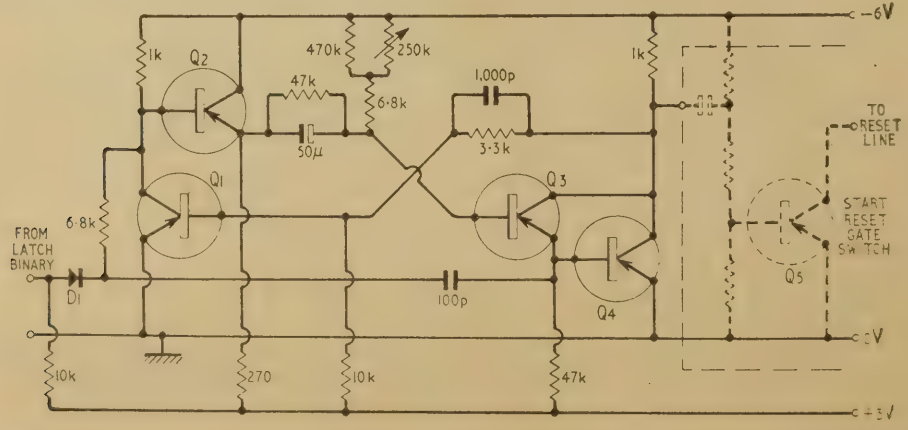


Fig. 99. Start reset delay monostable circuit. All transistors are silicon v.h.f. type.

WORLD OF WIRELESS

International Colour TV

ANOTHER series of demonstrations of colour television is being staged in London during the last week of October for some 50 European delegates. The members of the colour television *ad hoc* group of the European Broadcasting Union have invited representatives of the Eastern European O.I.R.T. (International Radio and Television Organization) to attend and it is understood that five have accepted. In addition two members of the secretariat of the C.C.I.R. will also be present.

The delegates are meeting primarily to study results of additional tests made since the last meeting of the *ad hoc* group some months ago when it was felt there was insufficient information available on certain aspects of the various systems. One of the things that has come out of earlier discussions is the necessity for making tests over long circuits. It is therefore planned, during this meeting, to transmit each of the three systems, PAL, SECAM and N.T.S.C., over a circuit from London via Germany to Rome and back to London via France—the longest distance so far attempted. It has also been agreed in principle to arrange a London-Moscow-Paris link later in the year.

The London demonstrations are being staged by the B.B.C., the Independent Television Companies' Association, and some manufacturers.

A meeting of the *ad hoc* group will be held in Hilversum in December to study the results of these demonstrations and to produce a report which will be submitted to the meeting of the C.C.I.R. in Vienna next March at which it is hoped an international decision will be reached on a colour system.

This 85-foot dish at the U.S. Navy's Point Mugu tracking station in California was modified for the reception of the Olympic Games television transmissions via Syncom III by the Hughes Aircraft Company who designed and built Syncom.

Televising the Olympic Games

A SEVEN-STOREY building recently completed in Tokyo was the broadcasting centre for this year's Olympic Games. It contains seven television studios and forty-five sound studios. Some 80 television cameras, 32 video tape recorders (including two with slow-motion facilities), 30 microwave terminals, 700 audio tape recorders and 600 microphones are in use. Incidentally, after the Games the central broadcasting building will be modified to form part of a permanent broadcasting

Two of the television studios in the central broadcasting building were used by the E.B.U. member countries, of which Britain is one, to prepare material for transmission. To speed up the transmission of television pictures to Europe, use was made of Syncom III which is stationed above the Pacific at a height of approximately 22,300 miles mid-way between Japan and America. Highlights of the Games, recorded on video tape, were transmitted by microwave link from Tokyo to the new satellite ground station at Kashima and thence via Syncom III to Point Mugu in California. From there microwave links carried the recorded video signals across the U.S.A. to Montreal. The received signals were then re-recorded and flown—by chartered jet—to Hamburg, Germany, for feeding into the Eurovision network. The video recordings were converted from the Japanese 525-line, 60-field standard to the 625-line 50-field standard for feeding to those countries using it, but we in this country and France received the 525-line signal for "home conversion". The commentaries to accompany the pictures were sent via the normal cable and wireless links.

The cost of the use of the satellite and charter jet for the period of the Games is said to be in the region of £350,000. This will be met by the Eurovision countries.

This year's I.E.E. **Faraday Lecture** is being given by F. C. McLean, C.B.E., the B.B.C.'s director of engineering. His subject is "Colour Television." These annual lectures are designed to appeal to the layman and are given in a number of provincial centres as well as in London. Mr. McLean will deliver his lecture first in Swansea on November 24th and in Bristol on the 26th. The London lecture will be on February 17th at 6.0 in the Central Hall, Westminster. The lecture tour includes Birmingham (Jan. 19); Leicester (Jan. 21); Manchester (Jan. 26); Stoke-on-Trent (Jan. 28); Portsmouth (Feb. 9); Bradford (Feb. 24); Sheffield (Mar. 2); Belfast (Mar. 18); Edinburgh (April 1); Newcastle (April 6). Admission is by ticket obtainable from the local centre of the I.E.E. In most centres Mr. McLean will repeat his lecture on the following day to an audience of students.

Trafalgar Square Television.—A Marconi large-screen colour television projector, modified for back projection of black and white pictures, was installed in Trafalgar Square to show the waiting thousands the B.B.C. television coverage of the General Electeion as the results became known. The projector, installed and operated for the B.B.C. by Colour Television Engineering Services Ltd., used three E.E.V. high-brightness projection c.r. tubes.

"The Age of Automation." is the title of this year's B.B.C. Reith Lectures which are to be given by Sir Leon Bagrit, the chairman of Elliott-Automation. Sir Leon will develop his ideas on automation in a course of six weekly lectures beginning on Sunday, 8th November, in the Home Service. Each lecture will be repeated in the Third Programme later in the week.

Amateur Television DX.—It is learned from the *R.S.G.B. Bulletin* that a new world record for amateur television was set up in this country on September 3rd. A 200-mile two-way vision and sound link was established between J. R. T. Royle (G3NOX/T), of Saffron Walden, Essex, and L. Hunton (G3ILD/T), of Darlington, Co. Durham. The vision frequencies used were 428 and 436 Mc/s. The Essex station used a power input at peak white of 150 watts and the Durham station 100 watts.

An additional aerial has been ordered from E.M.I. Electronics by I.T.A. for installation on the 750ft mast at St. Hilary, nr. Cardiff, to radiate a Welsh programme. It will transmit in Channel 7 (the existing aerial radiates in Channel 10) and will have a maximum e.r.p. of 100kW with the main lobes of its kidney-shaped radiation pattern directed towards the N.E. and N.W. The new aerial will be vertically polarized and is due to be completed by December.

BBC-2 test transmissions for the Birmingham area are expected to start in Channel 40 from Sutton Coldfield on 16th November. The actual service is scheduled to begin on 6th December.

Holland's second television service was introduced on 1st October. Initially it is being radiated by only one station—Lopik-IJsselstein. Both services are conducted by the Netherlands Television Foundation to which each of the five Netherlands broadcasting authorities contribute.

PAL, Telefunken's colour television system, has recently been demonstrated to Eastern European broadcasting authorities in Moscow and Sofia.

The next **German Radio and Television Show** will to be held in Stuttgart from 27th August to 5th September, 1965.

Asian Broadcasting Union.—The first general assembly of this Union, which formally came into being in July, will be held in Sydney, Australia, in November. Eleven broadcasting organizations have joined the A.B.U. which has its headquarters in Tokyo. The countries represented are Australia, India, Japan, Korea, Laos, Malaysia, New Zealand, Pakistan, Philippines, Taiwan and United Arab Republic.

***Six radar detectors,** are used with an electronic traffic analyser to control traffic lights at one of the major road junctions in Hamburg. The number, length and speed of all vehicles travelling along one lane are detected and this information is fed to the analyser in pulse form. Using this system, which is still undergoing tests in Hamburg, the traffic lights of a whole district can be regulated. Telefunken supplied the detectors and Standard Elektrik Lorenz the analyser.*

B.V.A. Officers.—F. V. Green, Brimar representative on the Council of the British Radio Valve Manufacturers' Association, has been re-elected chairman. The new vice-chairman is A. Deutsch (Thorn-A.E.I. Radio Valves & Tubes).

E. E. A. Joins EUROSPACE.—The Electronic Engineering Association, which represents the capital goods section of the British electronics industry, has joined EUROSPACE as a collective member. This European Industrial Space Study Group was formed in 1961 to promote space activities in Western Europe.

The I.I.T. Research Institute, formerly the Armour Research Foundation of Illinois Institute of Technology, has opened a European office at 1 Av. du Général Leclerc, Fontenay-aux-Roses (Seine), France. It will provide training in and information about the A.P.T. (Automatically Programmed Tools) system for programming numerically controlled machine tools.

Hong Kong-U.K. Trade Over £110M.—According to figures in the 1964 edition of the Hong Kong "Commerce, Industry and Finance Directory" the Colony's export of transistor portables for 1963 amounted to H.K.$68.3M (£4.2M) and shows an increase of almost 100% over the previous year's total. Copies of this 180-page review of Hong Kong's industrial growth are available, on receipt of a self-addressed label bearing 1s 2d in stamps, from the Hong Kong Government Office, 54 Pall Mall, London, S.W.1.

The **National** range of radio receivers, recorders and domestic electrical appliances made by the Matsushita Electrical Industrial Company, of Japan, are on show at the Japan Trade Centre, 535 Oxford Street, London, W.1, until 12th November. The exhibition is open to the public from 9.30 to 5.30 on Mondays to Fridays.

Semiconductor Diodes.—Two new colour filmstrips have been introduced by the Mullard Educational Service. The first, entitled "Basic principles of semiconductor diodes" (30 frames) gives a detailed description of intrinsic, p-type and n-type semiconductors.. The second strip, entitled "Practical semiconductor diodes" deals with the processing of materials, the construction of devices and characteristics. Other items of interest in this 25-frame strip include avalanche Zener and tunnel effects, and the high frequency and thermal limitations of diodes. Both strips are available from the distributors, Unicorn Head, Visual Aids, Ltd., 42 Westminster Palace Gardens, London, S.W.1. Comprehensive teaching notes are included in the price of 25s per strip.

Reporting at the annual general meeting of the **Electrical Industries Benevolent Association** the retiring president, F. E. C. Miller, drew attention to the fact that the Association suffered a deficit of £5,660 last year compared with a surplus of £6,500 the year before. The Association, which last year helped 2,000 people, is supported entirely by voluntary contributions.

The **"Handlist of Basic Reference Material"** for librarians and information officers in electrical and electronic engineering has been revised by the ASLIB Electronics Group. It is broken down into the following sections; enclyopædias and dictionaries, handbooks and yearbooks, trade directories, guides to literature (sub-divided into book lists, periodicals, lists and subject bibliographies), standards, tables, valves, tubes and transistors handbooks, technical writing and terminology and guides to sources of information. Copies of this 48-page publication are available, price 12s, from Miss B. Newman, Ericsson Telephones, Beeston, Notts.

A symposium on the theory and application of the **silicon gate-controlled switch** will be held at Enfield College of Technology, Queensway, Enfield, Middx., on 2nd December.

PERSONALITIES

Sir Robert Cockburn, K.B.E., C.B., M.Sc., Ph.D., chief scientist of the Ministry of Aviation, has been appointed director of the Royal Aircraft Establishment, Farnborough, in succession to **Dr. M. J. Lighthill,** F.R.S., who is taking up a Royal Society Research Professorship. Sir Robert, who is 55 and was knighted in 1960, taught physics at Portsmouth and West Ham Municipal Colleges before joining the Radio Department of the Royal Aircraft

Sir Robert Cockburn

Establishment in 1937. Two years later he became head of the Radio Countermeasures Division of T.R.E. (now Royal Radar Establishment), Malvern. In 1945 he transferred to atomic energy research and three years later was appointed scientific adviser to the Air Ministry. He became principal director of scientific research, guided weapons and electronics, in the Ministry of Supply in 1954. In the following year he was appointed deputy controller of electronics, a year later controller of guided weapons and electronics, and since 1959 has been chief scientist.

M. Lionel Jofeh, O.B.E., M.I.E.E., managing director of Sperry Gyroscope Company for the past two years has additionally been elected chairman of the board. He joined Sperry in 1947 to undertake research and development work on radar, fire control and missile systems and 10 years later became chief engineer. In 1959 he was appointed manager of the newly formed industrial division and in the following year joined the board. Prior to joining Sperry Mr. Jofeh, who is 51, was for 11 years with Cossor, first as a television research engineer and later as technical assistant to the director of research. He was appointed an O.B.E. in 1956 for his work on defence projects.

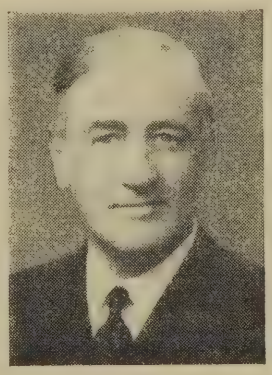
Sir Ian Orr-Ewing, Bt., O.B.E., M.P., M.A., M.I.E.E., has accepted the invitation of the recently formed Society of Electronic and Radio Technicians to become its first president. Sir Ian, who resigned from the Government as Civil Lord of the Admiralty in 1963, started his career in the radio and electronics industry as a graduate apprentice with E.M.I. in 1934. After war service, during which he was at one time chief radar officer, air staff, S.H.A.E.F., he was manager of the B.B.C's television outside broadcasts, and from 1949-57 was a director of A.C. Cossor. He is now chairman of United Dot Products and Carr Fastener Co. Ltd.

J. T. Wiltshire, M.A., has been appointed controller of G.E.C. (Electronics) Ltd. with responsibility for finance and production. He has been the company's director for commercial and production matters for two years. Prior to joining G.E.C. Electronics Mr. Wiltshire, who is 44, was divisional manager and co-ordinator of a complete guided missile system with E.M.I. Electronics. He joined R.E.M.E. as a regular officer from Cambridge (where he obtained double First Class Honours in Mathematics and a Research Scholarship) and was an instructor at the Military College of Science.

Three appointments are announced by A.E.I. following the reorganization of the company's valve and semiconductor business at Lincoln. **Eric Willis-Jones** becomes general manager, semiconductors, and will be responsible for the design, production and marketing of semiconductor devices. He was previously commercial manager of the Lincoln valve & semiconductor department. **H. W. Cumming** has become project manager, semiconductors, responsible for the development and production of all devices at A.E.I. Lincoln. He joined A.E.I. (Siemens Bros.) in 1956 after 16 years with Siemens Electric Lamps and Supplies. In 1958 he was appointed chief engineer, semiconductors, with Siemens Edison Swan at Woolwich and two years ago transferred to Lincoln as assistant manager, engineering. **Michael W. Blades,** who has been assistant manager of the Lincoln semiconductor sales department, becomes commercial manager. Mr. Blades, who is 35, joined the Brimsdown factory of A.E.I. (Edison Swan) in 1953. In 1961 he transferred to the radio and electronic components department as deputy chief engineer later becoming head of semiconructor product research at Lincoln.

A. Geoffrey Slemeck, B.A., marketing director of Standard Telephones & Cables, has been made president and managing director of I.T.T. Standard, the European marketing organization of International Telephone & Telegraph Corp., and will be based in Brussels. He joined S.T.C. in 1946 after war service in the Royal Navy, in which he reached the rank of Lieutenant Commander, and has been a director since 1962. The new marketing director of S.T.C. is **K. P. Wood,** B.Sc.(Eng.), M.I.E.E., who joined the company in 1962 from British Communications Corporation Ltd. where he was director and general manager. He has been manager of S.T.C's radio division and is also a director of the two subsidiaries coming under the management of the division—International Marine Radio Company and Hudson Electronics Ltd. Mr. Wood was at one time head of the Electrical Engineering Department at Medway College of Technology, Rochester, and from 1956-1961 was with Cossor.

H. E. F. Taylor, secretary of the Electronic Engineering Association since 1956, has retired. Mr. Taylor was a Lieutenant Colonel in the Royal Signals during the war and was concerned mostly with long-distance telecommunications projects. He has been a radio amateur for over 40 years, and whilst in India operated with the call VU2AT. His British call is G6HT. The new secretary of the Association is **A. S. Marshall,** who joined as deputy secretary in 1958 on retirement from the Royal



A. S. Marshall

Navy with the rank of Lieutenant Commander in the Fleet Air Arm. He was at one time in the Admiralty's Radio Equipment Department and later at the Admiralty Research Laboratory at Teddington.

INDUSTRY NEWS

M. Esterson, B.Sc., A.M.I.E.E., manager of the high power klystron department of English Electric Valve Company for the past two years, has been appointed personal representative of the managing director to undertake special duties concerning the integration of the recently acquired Lincoln factory into the Chelmsford organization. The high power klystron and microwave research sections will now be combined to form the microwave beam tube department of which **G. O. Chalk,** M.Sc., A.M.I.E.E., will be in charge. Mr. Chalk graduated at University College, Exeter, in 1950, and after

G. O. Chalk

service in the R.A.F. joined the Mullard Research Laboratories in 1953 where he was concerned with research and development of klystrons. He has been with E.E.V. since 1957 latterly as assistant manager of microwave research.

Dr. L. Rohde, of Rohde & Schwarz, of Munich, for whom Aveley Electric Limited are U.K. distributors, has joined the board of Aveley. The Company also announces the appointment to the board of **A. C. Green,** who has been works manager since he joined the company on its formation in 1954.

John R. Erskine, who was made chief engineer of Aveley Electric's Avel-Toroid Division on its formation in 1960, has been appointed chief engineer of Aveley.

Eric Lawson has joined Cosmocord, of Waltham Cross, to be manager of the new instrument division. He was previously in charge of test and instrumentation with Wilkinson Sword (Colnbrook) Ltd.

B. R. Pittaway, chief engineer of Electro Acoustic Industries Ltd. since 1959, has been appointed a director. Since joining the company in 1951 he has been concerned with the design and development of the Elac range of loudspeakers.

Thorn-Ultra.—It having proved impossible to reach agreement, the negotiations between Ultra Electric (Holdings) Ltd. and Thorn Electrical Industries Ltd. with a view to Thorn acquiring Ultra have been terminated. The negotiations were also concerned with Thorn's acquisition of the 40% interest in Ultra Electronics at present held by Electronics International Capital Ltd., of Bermuda. Ultra's domestic radio and television interests (Ultra & Pilot) were acquired by Thorn in 1961.

Australian Computers Pty. Ltd. is the name of a new company jointly formed by English Electric-Leo Computers Ltd. and Amalgamated Wireless (Australasia) Ltd. It has an authorized capital of £A200,000 and is operating from ADC House, 77 Pacific Highway, North Sydney, N.S.W. English Electric-Leo Computers have a 60% interest.

English Electric Leo Marconi Computers Ltd.—The English Electric Company has agreed to purchase J. Lyons & Company's shareholding in English Electric-Leo Computers Ltd., which was formed as a result of a merger of the two companies' computer interests in April of last year. The effect of this change in share ownership is that the computer company is to be directly connected with English Electric's principal electronics subsidiary, the Marconi Company, and will in future be known as English Electric Leo Marconi Computers Ltd. Sir Gordon Radley remains chairman and Mr. W. E. Scott continues as managing director; the Marconi Company will be represented on the board.

Aero Electronics Ltd. have acquired the production facilities of G3SJ Quartz Crystals Resonators Ltd. at Stonehouse Street, Plymouth, and Mr. M. H. Nicholas a director of Aero Electronics has joined the board of the company which will in future be known as Aero Electronics (Crystals) Ltd. Sales will be handled through the parent company's head offices at Gatwick House, Horley, Surrey.

Compagnie générale de télégraphie Sans Fil (C.S.F.) and the General Dynamics Corporation, of America, have joined forces to form a new company to manufacture satellite tracking equipment. The company, of which C.S.F. hold a controlling interest, is to be known as **Société d'Equipements Spatiaux et Astronautiques** (SESTRO) and will have headquarters in Corbeville.

Norwegian Training Vessel.—Associated Electrical Industries and Solartron have provided electronic equipment for the Norwegian Ministry of Shipping and Trade's new training vessel *M.S. Trondelag.* The A.E.I. Electronics Group has provided an "Escort" 13-in radar for the bridge and an "Escort 601" radar for the blind navigation training room. In addition, six "Escort" displays will work in conjunction with a Solartron Type SY 1194 simulator. One is a true motion display, and the other five are relative motion displays.

H.F. Distribution System for B.B.C. TV Centre.—A system of wired television using h.f. multipair techniques has been chosen to provide simultaneous distribution of up to 11 different television programmes plus the three B.B.C. sound programmes at the B.B.C. Television Centre at Wood Lane, London. Some 100 offices are covered by the Rediffusion system.

Choiceview, the registered name of the subscription television system developed by the joint Rank-Rediffusion research organization, is incorporated in the titles of two recently formed companies. They are Rank (Choiceview) Ltd., and Rediffusion (Choiceview) Ltd.

Beme Telecommunications Ltd., marine communications equipment manufacturers of 24 Upper Brook Street, London, W.1, who became part of the Derritron group of companies a year or two ago, is now to be known as Derritron Communications Ltd.

Crawford, Hansford & Kimber Ltd., of Farnham, Surrey, who make specialized electronic equipment for the industrial field, have recently entered the domestic market with a portable stereo record player called "The New Saturn."

E.E.V. Correspondence—Subsequent to their acquisition of the A.E.I. factory at Lincoln, all correspondence relating to export orders, Government contracts and microwave tubes should be sent to Chelmsford. Correspondence, however, concerning ignitrons, thermionic rectifiers, glass-to-metal seals, and all other products (except semiconductors) previously available from A.E.I. Lincoln, should now be addressed to English Electric Valve Co. Ltd., Carholme Road, Lincoln. (Tel.: Lincoln 26435.)

Complete checks of the aircraft's v.h.f. communications equipment, instrument landing system and V.O.R. omnirange beacon receivers in situ are effected by the QA8A test set in the foreground. The instrument is made by Standard Telephones and Cables Ltd. and is shown testing one of the TU-104 jets in the Czechoslovakian Airlines fleet.

Radar Display Systems.—The radar division of Cossor Electronics Ltd. has received an order, valued in the region of £200,000, for several Type CRD 100 transistor displays and associated equipment for the Ministry of Aviation's air traffic control training school and evaluation unit at Hurn Airport. This installation, which is to have 22 operational positions and two monitoring positions, will provide a system capable of accepting unprocessed radar data—from radar simulators, film recorders, video maps and external radar heads—and distributing, after processing, the information to any or all of the display positions.

The **S.T.C. entertainment range of transistors** marketed through Thorn-A.E.I. Radio Valves & Tubes Ltd. (Brimar) are in future to be distributed by S.T.C. Electronic Services, Edinburgh Way, Harlow, Essex.

Vactric Control Equipment Ltd. has acquired the whole of the issued share capital of A. P. Besson & Partner Ltd., whose products include miniature microphones, earpieces, transformers, and electromechanical and industrial equipment. Vactric Control also announces that it has exclusive manufacturing and sales rights for the Norden range of encoders in the United Kingdom and non-exclusive sales rights for the rest of the world with the exception of France, Canada and the U.S.A. A service and repair organization has been set up to cater for the encoders already in use in the U.K. and manufacturing plant is being installed at the company's premises in Garth Road, Morden. Norden is a division of the United Aircraft Corporation, of Connecticut, U.S.A.

U.K. manufacturing rights for the production of u.h.f. television transmitting aerial panels have been granted by **Rohde & Schwarz,** of Munich, to Racal Electronics Ltd., of Bracknell, Berks.

The American organization **Datapulse Incorporated** have signed an agreement with Digital Measurements Ltd., of Salisbury Grove, Mytchett, Aldershot, Hants., for the marketing of their pulse generators in the United Kingdom.

The Dutch range of **Jobo turntables,** which are made by Acoustical Handel Maatschappij N.V., of Holland, are available in this country from Colton & Co. (Lapidaries) Ltd., The Crescent, Wimbledon, London, S.W.19, who are the sole U.K. agents.

Dynaco Incorporated, of Philadelphia, have appointed Howland-West & Co., of 11 Howland Mews E., Howland Street, London, W.1, sole U.K. distributors of their range of products which includes several stereo amplifiers.

R. H. Cole Electronics Ltd. have moved from Caxton Street, Westminster, to 7-15 Lansdown Road, Croydon, Surrey. (Tel.: MUNicipal 4411.)

The **International Marine Radio Company,** formerly of Progress Way, Croydon, have moved to a larger factory in Peall Road, Croydon. (Tel.: THOrnton Heath 9771.)

The sales department of **Sydney S. Bird & Sons,** manufacturers of Cyldon components and accessories, has been transferred from Enfield, Middx, to the works at Fleets Lane, Poole, Dorset. (Tel.: Poole 1640.)

Jason Electronic Designs Ltd., makers of the **Jason** range of equipment and home-construction kits, and their associate companies Radio Traders Ltd. and the Lorlin Electronics Co., have moved from Wardour Street to Tudor Place, London, W.1. (Tel.: MUSeum 4666.)

ANNUAL REPORTS

The Plessey Company and its subsidiaries announce a trading profit for the year ended 30th June of £13,220,488, compared with £11,408,026 for 1962/63. After providing for taxation (£5,957,635, which is slightly up on the previous year) and setting aside £3,300,877 (£2,584,530) for depreciation and £860,000 to meet other deductions, the net profit for the year totalled £7,043,414 and shows an increase of £1,263,760 on the previous year's result. An indication of the company's activities may be obtained from the following percentage breakdown: telecommunications 53%; electronic and electrical products 16%; products for the consumer durable industries 14%; aircraft systems and equipment 8%; hydraulic and specialized engineering 6%; and telecommunications rental income 3%. Plessey-UK Ltd. increased their research and development effort and spent more than £5M in the year under review.

E.M.I. Group Profit Over £9M.—Pre-tax profits of Electric and Musical Industries Ltd. for the year ended 30th June, 1964, amounted to £9,104,000 and shows a considerable increase on the previous year's result of £5,058,000. Total group sales for the year were up nearly £10M at £94,675,000 and group trading profits rose by £4M to £11,679,000. Allowances for U.K. and overseas taxation almost doubled at £4,759,000 (£2,463,000) and so did the company's net profit of £4,161,000 (£2,405,000). All sections of the company, both at home and overseas, contributed to this improvement in the accounts.

Decca Profits Down.—Although the net profit of Decca Ltd. for the year ended 31st March, 1964, amounted to £1,339,000 and showed a slight drop on the previous year's result of £1,444,000, the consolidated turnover reached a new high level at £30,200,000 (£28,000,000). The record side of the business, which accounts for more than half of the consolidated turnover, showed increased profits, while on the electronics side there was a less favourable result.

Telefusion Ltd. announce that its trading profit for the 53 weeks to 29th April, 1964, was £2,010,554. This shows an increase of almost £300,000 on the previous year's result. Depreciation this year rose from £1,003,333 in 1962/63 to £1,235,943, whilst taxation charges dropped slightly to £79,516 (plus £8,686 taxation adjustments relating to the previous year). The net profit amounted to £669,135 compared with the previous year's £438,247.

Fourth International Battery Symposium

BRIGHTON, 29th SEPTEMBER — 1st OCTOBER, 1964

ORGANIZED by the Inter-departmental Committee on Batteries the Fourth Symposium with nearly 400 representatives from 22 countries was held at Brighton and was successful from many viewpoints not least the surroundings (in this connection it should be noted that the fifth Symposium will be held at the Hotel Metropole, Brighton, September 20th-22nd, 1966).

Lead-Acid Batteries: A paper on the old problem of initial voltage dip and peak in the discharging and charging curves of batteries by Dr. D. Berndt (Varta) gives an explanation for positive plates, hitherto not quite so detailed, on the basis of crystallization overvoltage (for the voltage dip case). In the case when the active material is pure αPbO_2 no dip exists and as yet there is still no satisfactory explanation for this.

Design and development of lead-acid batteries was discussed in a number of papers; the use of dispersion hardened lead (lead strengthened with a disperse phase of oxide) was one of the more interesting topics. This is found to increase the life of the positive plates but, of course, there are problems in the fabrication and joining, mainly because the lead cannot be melted or cast and consequently the processing is expensive or wasteful, involving either machining or stamping.

Sealed Cells: One of the most recent innovations in sealed cell technology is the use of an auxiliary electrode for improved overcharge capability and end-of-charge control. The Adhydrode control electrode has been developed, based on work by R. C. Shair and H. N. Seiger (Gulton Industries Inc.) on the theory of the mechanism of the oxygen reaction at the negative cadmium electrode in nickel and silver-cadmium cells. Electrons from a corrosion reaction due to a $Cd/Cd(OH)_2$ couple at the negative electrode, form adsorbed hydrogen at what has been termed the "Adhydrode" electrode and current flows through an external circuit to the negative electrode. This is greatest when oxygen arrives at the Adhydrode electrode (to react with the hydrogen) as the cell becomes fully charged. The current in the auxiliary electrode circuit is proportional to the oxygen pressure and thus a predetermined pressure can be set to control the end-of-charge. The Adhydrode provides a control method for recharging cells rapidly at high currents.

Solar Cells: Development of silicon photovoltaic cells continues to be dominated by space vehicle requirements. The major limiting factor for the extensive application of silicon cells on earth has been the high cost involved (in space high cost is not such a limiting factor). A paper by V. Magee and A. Bardsley (Ferranti Ltd.) described recent work aimed at reducing costs and mention is made of power generation costs of 0.1d/watt hour. Storage batteries (nickel-cadmium) obviously must be provided in a satellite since a third of the orbit time is in darkness, and J. L. Blondstein (B.A.C.), D. F. C. Poole (B.A.C.) and D. E. Mullinger (R.A.E.) discussed power regulation systems in satellites. A basic system would involve use of two batteries, a solar array and logic-controlled switching. The circuits must be arranged to trickle-charge the stand-by battery, isolate the load while discharged batteries recover, sense battery charge current, temperature, terminal voltage and cell pressure. In addition timing circuits may be needed to terminate charging or to reconnect the load after isolation and count orbits. In the system proposed for the UK3 satellite some 8,000 silicon cells are arranged in two groups, one for charging the batteries (twenty-two sealed nickel-cadmium cells of 3A-hr. capacity) and the other for supplying the load. The large number of cells used allows for a 25% reduction in all output due to proton bombardment.

Radio-Isotope Cell: Energy from radioactive emanations has been transformed into useful electrical energy as long ago as 1903, by collecting the beta particles from a radium source. The isotope used in this type of cell should be a beta emitter within an acceptable energy range, with minimal gamma radiations and a half-life compatible with the required operating life. The isotope must be available in suitable form and Krypton-85 was chosen for the cell discussed, in view of its low chemical activity. The choice of dielectric (separating source and collector) is governed in the first instance by its resistivity and resistance to radiation damage and these factors lead to the choice of polystyrene. Krypton, of course, is an inert gas and does not form any solid compounds, but it will form inclusion compounds or clathrates in which the krypton atoms are trapped in the host crystal lattice (hydroquinone) and cannot escape unless the lattice is broken. A cell measuring nearly an inch in diameter and $\frac{5}{16}$in thick can produce 500 volts at around 280$\mu\mu$A. The cell can develop 220 V across a 0.1μF capacitor (insulation resistance $10^{13}\,\Omega$) in a day and limits at 2.5 kV. With very low current gas diodes timing circuits and low-frequency sawtooth waveforms with periods of hours or even of days can be produced.

Fuel Cells: The choice of electrodes for acid electrolytes, preferred by many because of their ability to reject $C0_2$ thus enabling use of hydrocarbons directly, is an interesting question. Carbon and graphite are relatively inert but have a short life. Electrodes metallized with platinum, palladium or silver and using platinum-black pastes are rather weak mechanically, while those consisting entirely of platinum or palladium are expensive. P. Ruetschi and J. Sklarchuk (Electric Storage Battery Co., U.S.A.) discusses electrodes which only contain a very small percentage of the costly precious metals in a mechanically strong sintered-metal matrix. Ta, Nb, Zr, Ti and Pb have been investigated and titanium has been singled out for oxygen electrodes because of its low sintering temperature, ease of handling and relatively low price. But it was found that a long term disintegration probably takes place and tantalum and niobium may have to be used. For use in the hydrogen electrode tantalum and niobium appear to provide the best corrosion resistance. The amounts of platinum required for activation was of the order of 100 mg/cm^3.

A paper read in the absence of its authors (J. A. Le Duc and C. Lurie (M. W. Kellog Co., U.S.A.) was concerned with barium fuel cells which offer high current drain capability and one such cell can offer the same power delivery as seven or eight hydrogen-oxygen cells. These cells are, of course, continuous feed primary systems and solid barium fuel electrodes were coupled with oxygen and chlorine. The cells can handle large overloads and performed well at current densities of 1,000 A/ft^2. The results indicate that the barium systems have higher net energy densities per unit volume than any known electrochemical power source.

N.B. Of special interest to
P & T Authorities
Aviation Authorities
Armed Forces
and all who operate
point-to-point H.F Communications Systems

DOING THINGS BY HALVES IS OFTEN THE BETTER WAY

Take this new G430 series of Transmitters for example

By separating the drive-unit and amplifier, we have produced a 10kW p.e.p. transmitter costing no more than a conventional 'one box' unit, but which can also be operated economically at 1.5kW by feeding the output from the driver — a Redifon G420 series Transmitter — straight into the aerial.

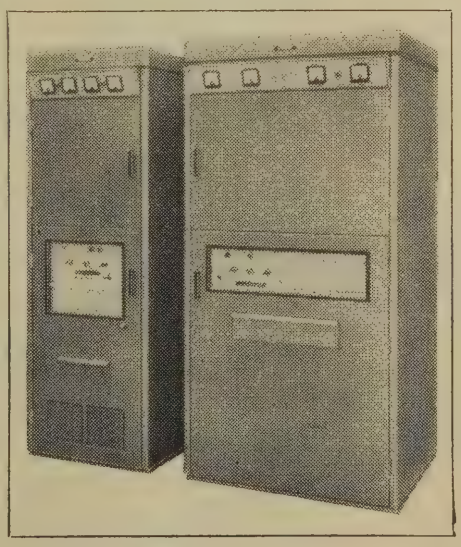
The Linear Amplifier covers 1.5 — 30Mc/s and can be operated, or shared in turn, by any suitable drive transmitter with an output of 500W.

CW, MCW, SSB, DSB or ISB services are available, with a choice of manually operated or servo-controlled versions. External units can be added for FSK or twinplex telegraphy or facsimile.

If you will give us some idea of your operations we will send you the significant details.

Redifon

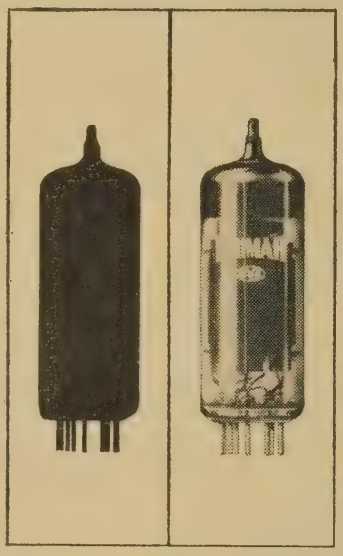
REDIFON LIMITED
Communications Division,
Broomhill Road, London, S.W.18
Tel: VANdyke 7281



A Member Company of the Rediffusion Group

14WW—106 FOR FURTHER DETAILS.

Brimar puts life into new valves



BRIMAR

When Brimar valves are assembled, heated, pumped to the highest degree of vacuum and finally sealed in their glass envelopes, they are complete – but the spark of life is yet missing.

On a machine as ingenious and as bizarre as any from the world of science fiction, the valves are arranged in banks on a series of moving platforms. At each stop on their journey around a huge revolving table, arrays of light bulbs glow and flash as varying voltages are automatically applied for varying lengths of time to grids, cathodes and anodes. This removes the last residual traces of gas from the electrodes and brings every working surface up to optimum working condition.

But the valve that springs to life is very much of this world – a component of a precision and consistency of quality that only Brimar's brand of production engineering ingenuity can produce.

Thorn-AEI Radio Valves & Tubes Ltd.

HEAD OFFICE
155 Charing Cross Road, London WC2. GERrard 9797

EXPORT DIVISION
Thorn House,
Upper St. Martin's Lane,
London WC2

14WW—107 FOR FURTHER DETAILS.

Introduction to
Practical Transistor Circuit Design

3.–TOLERANCES AND BIASING

By G. P. HOBBS,* B.A., Grad. I.E.E.

SOME radical properties of the two forms of transistor are depicted in Fig. 1. Normal operation is with one junction (base-emitter) forward conducting and the other (collector-base) biased in the reverse direction. At Fig. 1(a) a positive pulse applied to the base initiates collector current and the collector terminal then assumes some potential within the bounds set by the supply rails. By contrast the base potential will always remain linked, within a matter of a few hundred millivolts, to the emitter potential.

Two further circumstances may befall the transistor:

(1) *Where the base is driven to cut off the flow of collector current.* The drive will then be in the opposite direction to that shown in Fig. 1 and the potentials of all three electrodes become "free."

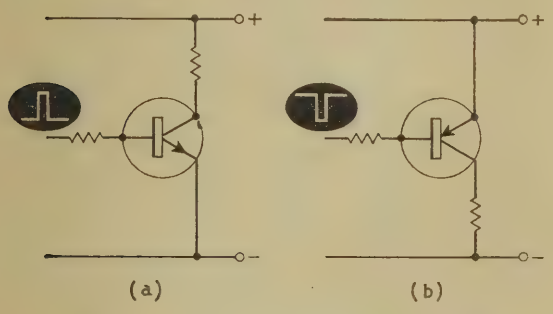


Fig. 1. Collector current flows (a) in an n-p-n transistor for a positive base drive and (b) in a p-n-p transistor for a negative-going drive.

(2) *Where sufficient drive is applied to bottom the stage as indicated by a change in the polarity of* V_{CB}. In this condition all three electrodes become tied together, linked within orders of a few hundred millivolts.

These conceptions of transistor behaviour are essential to the problems of biasing whether the stage is acting as an amplifier or a switch. This article will consider the issues of leakage current and of tolerance in current gain for the transistor acting as an amplifier, while the final article will deal with the subject of base-emitter voltage variation both for amplifiers and switching stages.

In an amplifying stage the working condition is somewhere between the cut off and bottomed conditions. The biasing requirements are therefore more exacting than for either of the two latter limiting conditions.

Let us consider how we might forward-bias the transistor to set up a standing collector current. The two extreme possibilities would be either to apply a small bias voltage to the base terminal with respect to the emitter, or to supply the base with a bias current from (ideally) an infinite source resistance. Under the first procedure the standing current would be influenced by any change in the base-emitter voltage, V_{BE}. By the second method, a change in the current gain, β, would influence the standing current. For both examples the transistor leakage current will displace the working point (but to different extents) and upon all these factors temperature wields a considerable influence.

The problem of biasing is indeed more complex than many would like to admit. Leaving aside V_{BE} variation to the final article we must now consider the subject in detail.

Dependence of the Current Gain on I_C and Temperature:—For a start the typical variation of current gain with collector current is shown in Fig. 2. Strictly it is the d.c. current gain h_{FE}, that is relevant to the biasing question, but here we shall choose to ignore the difference between h_{FE} and h_{fe} (or β) as we shall need to make use of some of the information on parameters discussed in the first article in this series. Generally it will be found worth while only to draw the distinction in high current stages where the incremental current gain has begun to fall away from its maximum value.

A wide range in current is covered by the horizontal logarithmic scale of Fig. 2 and it is only in high-power stages where the amplitude of signal swing could cover such a wide range that the linearity might suffer from change in β. It will be remem-

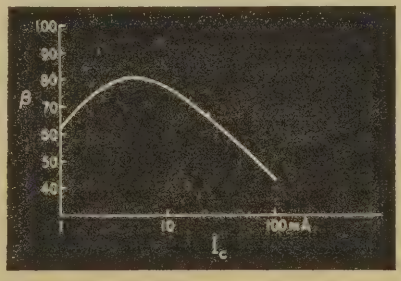


Fig. 2. Variation of current gain with collector current.

*The Marconi Company Ltd., Chelmsford, Essex

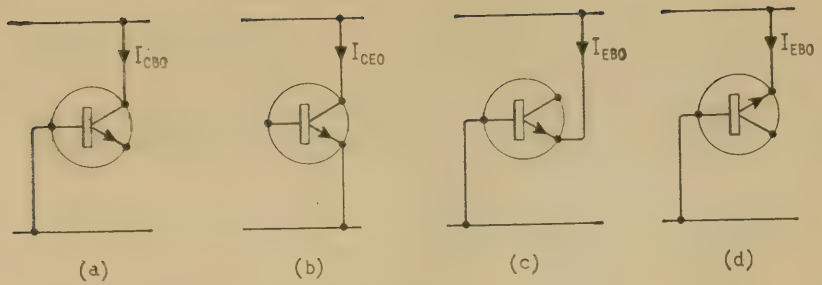


Fig. 3. Designations for leakage currents.

bered that changes in input impedance or g_m are the principal causes behind non-linearity in small signal stages. The main purpose of Fig. 2 is not to show non-linearity, but to demonstrate how the value of β at the chosen operating current can differ from the value quoted in the maker's data. The maximum and minimum values quoted for, say, $I_C = 10mA$ would need to be modified in the light of Fig. 2 if the chosen standing current were to be 100mA.

A second, probably more important but often neglected, influence on the limits of β is temperature. β is found in practice to increase with temperature and by quite appreciable amounts: typically between +0.3% per °C and +0.8% per °C. Over the temperature range 0°C to +50°C β could, for instance, drift from a figure of 75 up to 90. So again if we are to design for a wide range of temperature, the extreme maximum and minimum values of β may not directly correspond to the figures quoted in the manufacturer's data; the tolerances may extend further.

All this has really been to show how necessary stabilization can be. Now as a preamble to discussing stabilization against tolerance in β, the problem of leakage current will be examined.

Leakage Current:—In germanium transistors, the generation of leakage comes principally from within the body of the semiconductor; it is a bulk phenomenon. Thermal agitation disrupts electrons from the lattice network of the atoms that form the semiconductor and the so-called electron-hole pairs are produced. The number of electron-hole pairs generated depends on the temperature and on the potential energy associated with their breaking away from the lattice. Normally, electron-hole pairs are recombining as fast as they are formed and the total number remains constant at a given temperature. In the presence of a steep potential gradient such as occurs in the depletion region of the collector junction, the charges will, on the other hand, be swept away before recombination can take place. This charge flow constitutes the leakage current; in diodes it is known as a reverse current. It is characterized by being solely dependent on temperature and originates at a reverse biased junction. Even at very low collector-to-base voltages, the majority of current carriers are swept away before recombination has a chance to take place and no further increase in the applied voltage can appreciably increase the current flow; the leakage is a saturation current.

At least it is true to say that the leakage current is constant up to the point where the electrons gain sufficient energy, whilst accelerating through the potential gradient, to ionize further atoms by collision. In producing additional electron-hole pairs, the process multiplies. It is an avalanche phenomenon and is one mechanism for the voltage breakdown in transistors[1].

There is a fundamental diode equation for semiconductors which shows that the dependence of leakage current on temperature is exponential. Leakage increases rapidly with temperature and in the absence of data, a handy rule of thumb is to double the figure at 25°C for each further 10°C rise of junction temperature. From time to time one comes across quotations for the temperature rise corresponding to a doubling of the leakage current which are either greater or smaller than our choice of 10°C. Really this should be no matter for concern; the rule is only intended as a general guide and the true source of accurate data must be the responsibility of the manufacturer of the device.

Besides the bulk phenomenon, another leakage component is that across the surface of the semiconductor element. In germanium transistors the *proportion* of surface to bulk leakage is small. In silicon, the relative proportion can be significantly higher, because the semiconductor potential energy associated with electron-hole formation is greater and consequently the leakage contribution by the bulk component is several orders of magnitude down. Considered quantatively, however (i.e., in terms of actual current flow), both the surface and the bulk leakage components are small enough to be neglected. (Nobody quite seems to have unravelled the full story for the mechanism of leakage in silicon types and it would therefore be unwise to generalize over a figure for the temperature law.) In this article, when matters of leakage arise, the discussion is intended to be relevant to germanium transistors only.

It is the temperature in the region of the semiconductor junctions which is relevant where leakage current and β variations are concerned, for this is the operative region of the transistor. Because heat is carried away from this region, the area of the junctions must prove to be the hottest part of the transistor, The junction temperature is always higher than the case temperature and in turn the case is always above ambient. (But the case temperature can be brought closer to ambient by the means of a heat sink.) Where data on thermal resistance is available, the excess of junction temperature over the case or ambient temperature can be estimated from a knowledge of the power input to the transistor. This and a method for measuring the junction temperature of a transistor in circuit will be described in the final article in the next issue.

The basic leakage current arises, as we have said,

[1] "Voltage Breakdown of Transistors," by S. C. Ryder-Smith, *Electronic Technology*, October, 1961

in the collector-base junction; it is given the symbol I_{CBO}. The transistor being a three-terminal device has at least three important leakage currents. Each is measured between a pair of terminals. The basic one, I_{CBO}, is measured between collector and base with the emitter left open-circuit. The terminology should be apparent, but Fig. 3 is included to illustrate it.

The measurement is made at the first subscript with reference to the second and the plight of the third terminal is shown by the third subscript. In most instances the leakage will be measured with the third terminal open-circuit as designated by an 'O.' 'S' is used to indicate short circuit, and 'R' to indicate some specified resistance, in each case between the third terminal and the reference terminal (second subscript). The older designation for I_{CBO} (Fig. 3(a)) was I_{CO}, generally read as "I cut-off"; I_{CEO} (Fig. 3(b)) was sometimes written as I'_{CO}. The new descriptions reveal the definitions of the respective leakage currents quite unambiguously.

The identical subscript terminology has been made to serve transistor voltage ratings as well. The ratings may depend on the choice of reference terminal and the state of the third terminal, and it is for instance necessary to distinguish between V_{CBO}, V_{CEO} and V_{CER}[1]. Very often the voltage ratings are quoted in terms of minimum breakdown voltages and the appropriate terms would be BV_{CBO}, BV_{CEO} and BV_{CER}. It is a little difficult to define the exact value of a breakdown voltage; it would be said to occur in the region where the collector characteristics begin to turn round and run away. The standing collector current ought to be stated when quoting breakdown voltages, for higher operating voltages are possible at lower currents.

Fig. 3(c) shows the leakage current associated with the emitter junction, I_{EBO}. Although the base-emitter junction in its operative state is forward-biased, reverse-biasing will occur in switching stages and it is conceivable that I_{EBO} could be a relevant design factor. Naturally, when the emitter-base junction is reverse-biased it behaves in the same fashion as a collector-base junction. I_{EBO} is redrawn in Fig. 3(d) with the transistor "the wrong way up" to emphasize the similarity to Fig. 3(a). The order of magnitude of I_{EBO} will be the same as I_{CBO}, particularly so for a so-called symmetrical transistor. A symmetrical transistor will perform almost as efficiently (that is with a reasonable value of β) when collector and emitter are interchanged. They are of value in certain types of switching circuits.

I_{CEO}, the leakage across both the collector-to-base and base-to-emitter junctions remains to be discussed. The only reverse-biased junction is the collector-to-base one and leakage I_{CBO} therefore originates at this junction. However, in flowing to earth it must need to pass through the base-emitter junction where, like all base currents, it initiates a collector current β times as great by transistor action. If this argument proves unacceptable then the reader may consider it helpful first to imagine I_{CBO} drawn off at the base to complete the journey of I_{CBO}, and then to follow this move by reinserting a current equal in magnitude to I_{CBO} back into the base terminal to satisfy the boundary condition that the base lead is open-circuit. This reinserted current then gives rise to an additional collector current of βI_{CBO}, giving a total of $(\beta + 1)I_{CBO}$. To sufficient accuracy we may write $I_{CEO} = \beta I_{CBO}$[1]. It must be emphasized again that the quantity I_{CBO} is the fundamental leakage component, and that I_{CEO} is the *measured* "leakage current" when the base terminal is made open circuit.

Collector Leakage Current for the General Case:—So much for the specialized leakage currents; our ideas must now be extended to cover the general case in which there is some specific resistance connecting the base and emitter terminals.

Consider once more the current I_{CBO} proceeding from the collector junction. As it has been said the impedance from base to ground is low, but now, Fig. 4(a), there are two contending paths for the current to take. The impedances they present are R_B and $\beta(r_e + R_E)$; the proportion of the current I_{CBO} passing through the base-emitter junction will be a fraction $\dfrac{R_B}{R_B + \beta(r_e + R_E)}$ of the whole and through R_B a fraction $\dfrac{\beta(r_e + R_E)}{R_B + \beta(r_e + R_E)}$ of the whole.

The former gives rise to a collector current β times greater, by transistor action again, and the total leakage becomes

$$\frac{\beta(r_e + R_E) + \beta R_B}{R_B + \beta(r_e + R_E)} \cdot I_{CBO} \qquad (\beta >> 1)$$

that is

$$\frac{r_e + R_E + R_B}{r_e + R_E + \dfrac{R_B}{\beta}} \cdot I_{CBO} \text{ or } S.I_{CBO} \quad .. \qquad (2)$$

It is usual to employ an emitter resistor very much greater than the resistance r_e, so that the factor S we have introduced above becomes

$$S = \frac{R_E + R_B}{R_E + \dfrac{R_B}{\beta}} \quad .. \qquad (3)$$

This, the stability factor, relates the leakage in the general case to the basic leakage current I_{CBO}. Expression (3) is perhaps the most practical way of writing the stability factor although some people may be more familiar with the form $S = \dfrac{1}{1 - \dfrac{\alpha R_B}{R_E + R_B}}$ or other related expressions.

Examination of equation (3) shows that S must lie in the range from unity to β. The best stability is realized when R_B is small compared to βR_E, when a good approximation for S is $\dfrac{R_B}{R_E}$. In the limit, of

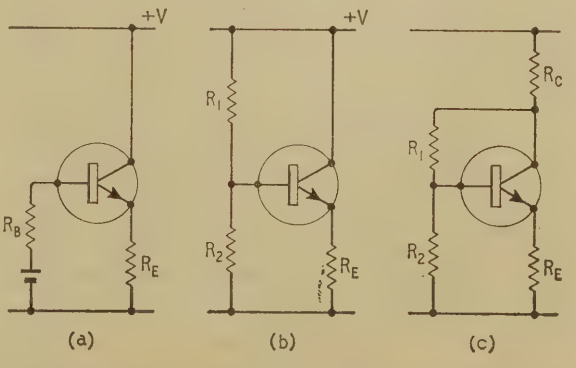


Fig. 4. Leakage current when there is some specific resistance between base and emitter.

course, the smallest leakage that one can aim for is I_{CBO} as S tends to unity. The largest is I_{CEO} which, as we found at (1) is βI_{CBO}. The value of β one employs in equation (1) is influenced naturally by the standing current. This is mentioned because the value of β at low currents may fall off appreciably and so the value of I_{CEO} in the absence of any external forward bias will be smaller than might at first have been imagined. Furthermore, as I_{CEO} is dependent on the current gain its maximum value is rarely quoted by manufacturers except in the case of silicon transistors. Its maximum value for germanium transistors could be alarmingly high, but in a well stabilized circuit where the leakage is closely related to I_{CBO} and not to I_{CEO} this would not matter.

The practical arrangements for the potentiometer method of biasing are depicted in Figure 4(b). Drawing the comparison with Figure 4(a), we can see that R_B should be given the value $R_B = \frac{R_1 R_2}{R_1 + R_2}$ and to set up a similar standing current the far end of R_B should be taken to a potential $\frac{R_1}{R_1 + R_2} \cdot V$. In many instances, the biasing arrangement, whilst not being as simple as shown in Fig. 4 (b), will reduce to the equivalent circuit of Fig. 4(a). A further improvement in the stability is effected where R_1 is returned to the lower end of a collector load, R_C, rather than to the rail—Fig. 4(c). Provided that R_1 remains several times greater than the value of R_C, the stability factor may be found from: $S = \frac{R_E + R_B}{R_E + R_B\left(\frac{1}{\beta} + \frac{R_C}{R_1}\right)}$. Unless R_1 is split into two and the centre tap decoupled, the input impedance at signal frequency will be considerably lowered by the feedback that this method of biasing introduces.

The Stability Factor Applied to β Tolerance:— The biasing current is supplied through a resistor network which in our generalized diagram of Fig. 4(a) is a single resistor fed from a voltage source $\frac{R_1}{R_1 + R_2} \cdot V$. Suppose this resistor R_B takes a very large value such that the biasing current is held at a fixed amount. Any change in the value of β will then produce a proportionate change in the standing collector current. Where I_C and β are treated as mean values a change in current gain $\Delta\beta$ causes a shift in the collector current of $\Delta I_C = \frac{\Delta\beta}{\beta} \cdot I_C$. Naturally when R_a has a finite value there is some compensating action in the circuit; a change in biasing current alters the voltage drop across R_B and this to some extent offsets the chance in collector current. The contribution to ΔI_C will be less than $\frac{\Delta\beta}{\beta} \cdot I_C$ and it is no surprise to find that the actual contribution can be expressed in terms of the stability factor as

$$\Delta I_C = S \cdot \frac{\Delta\beta}{\beta^2} \cdot I_C \quad \ldots\ldots\ldots \quad (4)$$

When S is taken equal to β in the expression, which means infinite R_B as in the case that we have just considered, the correct answer $\Delta I_C = S \cdot \frac{\Delta\beta}{\beta} \cdot I_C$ emerges.

Both leakage and β variation are concerned about changes of base current and it is easy to visualize that as such they are parallel problems. It is a little difficult, however, to give a simple justification for equation (4); for one thing β, I_C and I_B are all changing at once and for another S itself involves β. A mathematical derivation for equation (4) is therefore given in the appendix. Certain assumptions have to be made, of course, in deriving such a simple expression and only first-order accuracy is to be expected from it; leakage current is ignored for example. It may have slipped by unnoticed, but, in deriving equation (2), we correspondingly tacitly assumed that β was constant.

To give some confidence in the use of equation (4) we will consider just one other extreme case. We will make R_E large and drive the stage from a voltage source so that the stability factor becomes unity. At a first glance at the problem, the stability would be thought to be so good that there could be no change in collector current with variation of β. In fact there is some because it is the emitter current which is held constant and the collector current must differ from the emitter current by I_B. ($I_C = I_E - I_B$). An increase in β causes a decrease in I_B and an increase again in I_C. The proportionate change in base current will be $\frac{\Delta\beta}{\beta} \cdot I_B$, that is to say $\frac{\Delta\beta}{\beta^2} \cdot I_C$ and it is to be expected that this should equal ΔI_C. This is indeed what equation (4) reduces to when S equals unity.

Establishing the Working Point:— In an amplifying stage, one of the basic decisions will be the choice of operating current around which the design is to be worked out. Just as in valve circuits the anode current will first be chosen, the requirements of the design will dictate an approximate value for the collector current. The chosen collector current will however be quite nominal because the tolerances, including the ones on β and the leakage current, will not allow the same current to result in every case (Circuits which employ preset components for setting up will still be liable to suffer from temperature drift and the inclusion of preset components anyway suggests an attitude of defeat).

It will be helpful if we can choose a mean value for I_C such that possible departures away from this nominal value range equally on either side of I_C. Denoting this " design-centre current " by $\overline{I_C}$ and the maximum deviations by $\pm \Delta I_C$, the possible range of standing currents becomes $\overline{I_C} - \Delta I_C$ to $\overline{I_C} + \Delta I_C$. Whether such a range in collector current will be acceptable will be in a decision individual to each design. Here we need to discover how to design for $\overline{I_C}$ and how to calculate the contributions to ΔI_C.

The principle of working on a design centre is familiar enough, but with transistors its implementation proves to be a little tricky. Tolerances are not quoted plus and minus about mean values, but are given as extreme maximum and minimum limits. Although " typical values " often appear, these are not representative of any special mean of the limiting values. Reliance upon such " typical values " in design work can be a dangerous practice.

Let us consider how to choose a mean value of

current gain, β, which results in equal shifts in I_C as β varies from β_{min} to $\bar{\beta}$ and from $\bar{\beta}$ to β_{max}. At (4) we have stated that $\Delta I_C = S.\frac{\Delta\beta}{\beta^2}.I_C$, so that for fixed values of S and I_C we may write $\Delta I_C \propto \frac{\Delta\beta}{\beta^2}$. It can then be deduced that the desired value of $\bar{\beta}$ is the reciprocal of the mean reciprocals of the extreme values β_{min} and β_{max}.

$$\bar{\beta} = \frac{2\beta_{min}\,\beta_{max}}{\beta_{max}+\beta_{min}},$$ and in terms of $\bar{\beta}$ and β_{min}

$$\Delta I_C = S.\left(\frac{\bar{\beta}}{\beta_{min}} - 1\right).\frac{\bar{I_C}}{\bar{\beta}}$$

As an example suppose β_{min} (at the lowest working junction temperature) is 25 and β_{max} (at the highest temperature) is 100, then $\bar{\beta}$ works out to be 40. Had the extreme values been 25 and 125 respectively, then $\bar{\beta}$ would have worked out at 42. $\bar{\beta}$ lies closer to β_{min} than to β_{max} and is more critically dependent on the precise value of β_{min} than on β_{max}. That variations in β_{max} have the lesser effect on $\bar{\beta}$ is hardly surprising because at the higher current gains, the voltage dropped by the bias current across R_B is small and the changes are also correspondingly small. β_{min} is obviously the more valuable piece of information and this fact is often reflected in manufacturers' specifications where sometimes no data at all are given for β_{max}. A good transistor features a high β_{min}; and whilst a wide tolerance in β is undesirable, it is better for the tolerance to extend towards the higher values of β than towards the lower

To embrace leakage current in the design centre system is straightforward. Taking the minimum leakage to be zero, we can include half the maximum leakage as a contribution to ΔI_C and take the other half into account when setting up $\bar{I_C}$. The contribution to ΔI_C is $\frac{1}{2}.S.I_{CBO\ max}$ where $I_{CBO\ max}$ corresponds to the maximum operating junction temperature. From the two influences we have been considering in this article, the total ΔI_C is

$$\Delta I_C = S.\left(\frac{I_{CBO\ max}}{2} + \left(\frac{\bar{\beta}}{\beta_{min}} - 1\right).\frac{\bar{I_C}}{\bar{\beta}}\right) \quad .. \quad (5)$$

We can write down also a condition which will ensure that the appropriate value of $\bar{I_C}$ is obtained:

$$v = \bar{I_C}\,R_E + V_{BE} + \left(\frac{\bar{I_C}}{\bar{\beta}} - \frac{I_{CBO\ max}}{2}\right).R_B \quad .. \quad (6)$$

v is the potential that would appear at the junction of R_1 and R_2 if no current were drawn off at the base terminal; it is the unloaded voltage dropped across the lower resistor of the bias chain. Having said this, the derivation of equation (6) should be self-explanatory. It is assumed that the greater part of the leakage current, I_{CBO}, flows through R_B as it will do in a well stabilized circuit, and sufficient accuracy is obtained by writing the voltage drop from this cause as $\frac{I_{CBO\ max}}{2}.R_B$.

Equation (6) will not necessarily represent the normal biasing condition (say at room temperature with average transistors), it is merely some mean state. It is important, however, that the unloaded

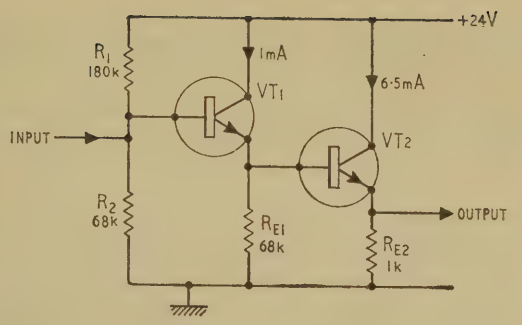


Fig. 5. Darlington pair with additional emitter resistor.

voltage, v, should be set up reasonably accurately so that the optimum use can be made of equation (5).

Design Procedure:—While it is not claimed that the design centre system will always be applicable, it is thought advisable to be aware of its implications. In many instances the designer may wish to discover, in an explanatory manner, where the limitations of his design lie. Equation (5) then displays at a glance the contributing factors to the d.c. stability, and shows what improvements might result when remedial measures are taken to improve the stability.

As an example of the method, Fig. 5 shows a Darlington pair.

The parallel combination of resistors R_1 and R_2 amounts to 49kΩ so that the ratio of R_B to R_E for the first transistor is 7 : 1. As previously stated we may take an approximate value for the stability factor equal to this ratio, 7. If β_{min} and β_{max} for VT1 are respectively 25 and 100, and if $I_{CBO\ max}$ is 70μA we can calculate that $S.\frac{I_{CBO\ max}}{2} = 225\mu A$ and that

$$S\left(\frac{\bar{\beta}}{\beta_{min}} - 1\right)\frac{\bar{I_C}}{\bar{\beta}} = 7.\left(\frac{40}{25} - 1\right).\frac{10^3}{40} = 105\ \mu A.$$

The sum of these gives $\Delta I_C = 330\ \mu A$. Although nominally the standing current is intended to be 1mA, the possible variations are from 0.67mA to 1.33mA. The unloaded voltage, v, at the top of R_1 and R_2 should be from equation (6), 6.8 + 0.25 + (0.025 − 0.035) × 49 which equals 6.56 volts. For a nominal 24 volts supply, values of 180kΩ and 68kΩ for R_1 and R_2 respectively will supply just this voltage.

It will be noticed that where we have calculated in equation (6) the quantity in brackets $\left(\frac{\bar{I_C}}{\bar{\beta}} - \frac{I_{CBO\ max}}{2}\right)$ representing the total bias current, this has taken a negative sign. The leakage current into the base region is more than enough to bias the stage and some of it has actually to be drawn out through the base lead. The base current is composed of the current in through the base terminal together with leakage from the collector junction which enters into the base-emitter junction internally. We must therefore allow for a current supply in either direction through R_B.

Now turning our attention to the second stage of Fig. 5 we can foresee a problem. At least there would be a problem in the absence of the resistor R_{E1} in the circuit. In the elementary form of the Darlington pair, there is no resistor R_{E1}, and the bias current

for the second transistor is supplied directly by the emitter of the first. VT1 emitter will unfortunately only supply current in one direction so that the d.c. stability, whilst being good at low temperatures, can suddenly go completely when the leakage current of the second transistor exceeds a certain value. One has, naturally, the possibility of employing a silicon transistor with its inherent low leakage for VT2; but the other alternative must be to fit this resistor R_{E1}. Again where the amplifier of Fig. 5 is required to handle fast pulses, trouble can arise in connection with the input capacitance of VT2 and the rectifying junction at the emitter of VT1. An emitter resistor R_{E1} is therefore advisable in the Darlington pair when it is used in pulse work or in wideband applications.

We have dealt with the stability of the first transistor of the circuit of Fig. 5. Provided that VT1 always remains conducting, the second transistor sees an impedance at its base of $\frac{49k\Omega}{\beta_1}$ which is much lower than the value of R_{E1}. The S factor for VT2 will therefore be close to unity and the stability be very good. The change in the working point of VT1 will however be directly reflected into VT2 because the emitter potential of VT2 must closely follow the emitter potential of VT1. The proportionate change in standing current for VT2 will then be of the order of $\pm$ 2.5 mA in 6.5 mA nominal.

APPENDIX

Here is a mathematical derivation of equation (4) for finding the change in collector current resultant upon a change in the current gain.

Fundamentally the potentiometer method of bias stabilization relies on the balance of a voltage drop across $R_E + r_e$ to that across the base resistor R_B. For any change in the *status quo* the following condition must be satisfied: (Change in emitter current) $\times$ $(R_E + r_e)$ = $-$ (Change in base current) $\times$ R_B ..... (1)

Since the base current is by definition $\frac{I_C}{\beta}$, the change ΔI_B is given by the partial differential $\frac{\Delta I_C}{\beta} - \frac{\Delta \beta}{\beta^2} I_C$, for small changes. $\frac{\Delta I_C}{\beta}$ is the result of a change in I_C with fixed β, and the $\frac{\Delta \beta_C I}{\beta^2}$ term corresponds to fixed I_C and changing β. The approximation "for small changes" means that only first order accuracy will be obtained, but this has already been accepted in the text of the article.

To find ΔI_E we must write $\Delta I_E = \Delta I_C + \Delta I_B$ and substitute $\Delta I_B = \frac{\Delta I_C}{\beta} - \frac{\Delta \beta}{\beta^2}.I_C$ into this identity.

Giving $\Delta I_E = \Delta I_C\,(1 + \frac{1}{\beta}) - \frac{\Delta \beta}{\beta^2}.I_C$.

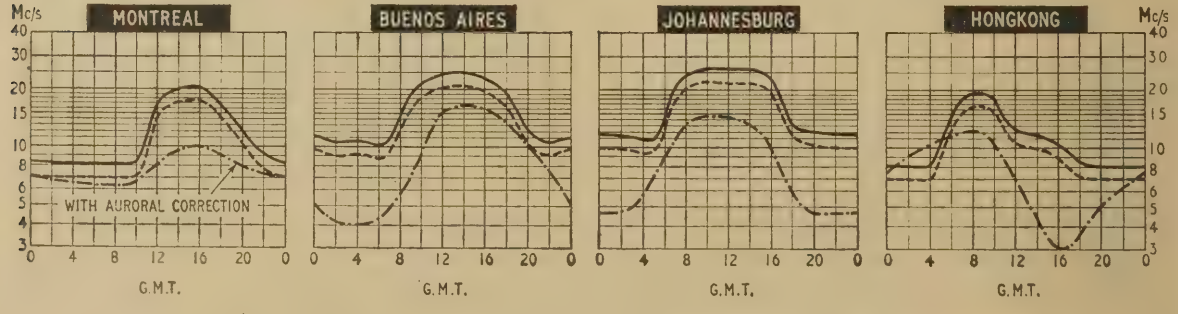
We now have expressions for ΔI_B and ΔI_E both in terms of ΔI_C and Δ_β, and can substitute both of these in our original condition at (1).

At the same time neglecting unity in comparison to β we obtain:

$$\Delta I_C \left\{ r_e + R_E + \frac{R_B}{\beta} \right\} = \frac{\Delta \beta}{\beta^2}.I_C\,(r_e + R_E + R_B)$$

But as the stability factor S is used to denote $\frac{r_e + R_E + R_B}{r_e + R_E + \frac{R_B}{\beta}}$, we have in fact $\Delta I_C = S.\ \frac{\Delta \beta}{\beta^2}.I_C$.

H. F. PREDICTIONS — NOVEMBER



The prediction curves show the median standard MUF, optimum traffic frequency and the lowest usable frequency (LUF) for reception in this country. Unlike the standard MUF, the LUF is closely dependent upon such factors as transmitter power, aerials, and the type of modulation. The LUF curves shown are those drawn by Cable and Wireless Ltd. for commercial telegraphy and assume the use of transmitter power of several kilowatts and aerials of the rhombic type.

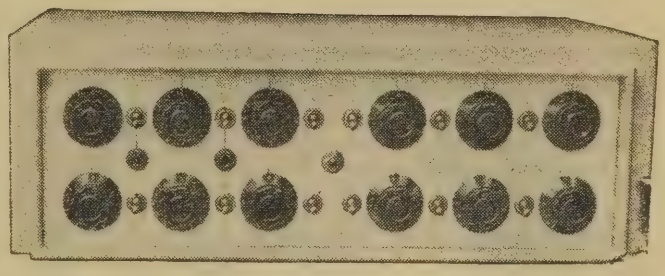
The higher daytime MUFs, characteristic of the winter months, are now becoming apparent for circuits predominantly in the Northern hemisphere. The Northern Auroral Zone passes through Alaska, Hudson Bay, Iceland and Northern Norway and radio paths passing through this zone are subject to additional absorption, for which a correction is made in the calculation of the LUF.

—Vortexion

quality equipment

12-WAY ELECTRONIC MIXER

The 12-way electronic mixer has facilities for mixing 12 balanced line microphones. Each of the 12 lines has its own potted mumetal shielded microphone transformer and input valve, each control is hermetically sealed. Muting switches are normally fitted on each channel and the unit is fed from its own mumetal shielded mains transformer and metal rectifier.



FOUR-WAY ELECTRONIC MIXER

This unit provides for 4 independent channels electronically mixed without " spurious break through," microphony hum and background noise have been reduced to a minimum by careful selection of components. The standard 15-50 ohm shielded transformers on each input are arranged for balanced line, and have screened primaries to prevent H.F. transfer when used on long lines.

The standard 5 valve unit only consumes 18.5 watts, H.T. is provided by a selenium rectifier fed by low loss, low field, transformer in screening box. The ventilated case gives negligible temperature rise with this low consumption assuring continuance of low noise figures.

20,000 ohms is the standard output impedance, but the noise pick-up on the output lines is equivalent to approximately 2,000 ohms due to the large amount of negative feedback used.

For any output impedance between 20,000 ohms and infinity half a volt output is available. Special models can be supplied for 600 ohms at equivalent voltage by an additional transformer or 1 milliwatt 600 ohms by additional transformer and valve.

The white engraved front panel permits of temporary pencil notes being made, and these may be easily erased when required. The standard input is balanced line by means of 2 point jack sockets at the front, but alternative 3 point connectors may be obtained to order at the rear.

Mixer for 200-250V AC Mains **£40 8 6**
Extra for 600 ohm output model **£1 18 6**
Extra for 600 ohm 1 milliwatt output **£3 0 6**
Size 18⅛in. wide × 11⅛in. front to back (excluding plugs) × 6¼in. high.
Weight 22 lb.

THREE-WAY MIXER and peak programme meter, for recording and large sound installations etc.

This is similar in dimension to the 4-Way Mixer, but has an output meter indicating transient peaks by means of a valve voltmeter with a 1 second time constant in its grid circuit.

The meter is calibrated in dBs, zero dB being 1 milliwatt-600 ohm (.775V) and markings are provided for +10 dB and −26 dB. A switch is provided for checking the calibration. A valve is used for stabilising the gain of this unit.

The output is 1 milliwatt on 600 ohms for zero level, up to +12 dB maximum. An internal switch connects the output for balance, unbalance, or float. This output is given for an input of 40 microvolts on 15 ohm.

An additional input marked "Ext. Mxr," will accept the output of the 4-Way Mixer converting the unit into a 7-Way controlled unit. This input will also accept the output of a crystal pick-up, but no control of volume is available.

The standard input is balanced line by means of 3 point jack sockets at rear, but alternative 2 point connectors may be obtained to order at the front or rear as desired.

The 8 valves and selenium rectifier draw a total of 25 watts.

P.P.M. for 200-250V AC Mains .. .. .. Price on application.
Size 18⅛in. wide × 11¼in. front to back (excluding plugs) × 6¼in. high.
Weight 23 lb.

10/15 watt Amplifier with built-in mixers.
30/50 watt Amplifier with built-in mixers.
2 × 5-way stereo mixers with outputs for echo chambers, etc.

Full details and prices on request.

VORTEXION LIMITED, 257-263 The Broadway, Wimbledon, S.W.19

Telephone: LIBerty 2814 and 6242-3-4 **Telegrams: "Vortexion London S.W.19"**

HIGH SENSITIVITY **LARGE BANDWIDTH**

20 mV/div **0 - 10 Mc/s**
2 mV/div **0 - 1.5 Mc/s**
(1 division = 8 mm)

NEW

PHILIPS

hf double beam oscilloscope

PM 3230

Clear, sharp picture provided by new "side-by-side" double-gun 10 cm (4 in) cathode ray tube with full scale horizontal and vertical deflection of both beams.

Clear, logical lay-out of front plate, resulting in quick and easy operation.

19 calibrated sweep speeds from 0.5 μs/div to 0.5 s/div, sweep expansion up to 5x

Jitter free triggering with simple controls stability being preset, special TV frame position

Largely transistorized

Compact and lightweight (11 kg - 24 lbs)

Full set of accessories available

Complete manual with full service instructions supplied with the instrument

Sold and serviced all over the world

Compartment for mains flex provided

Transparant dust cover with pockets for all accessories provided

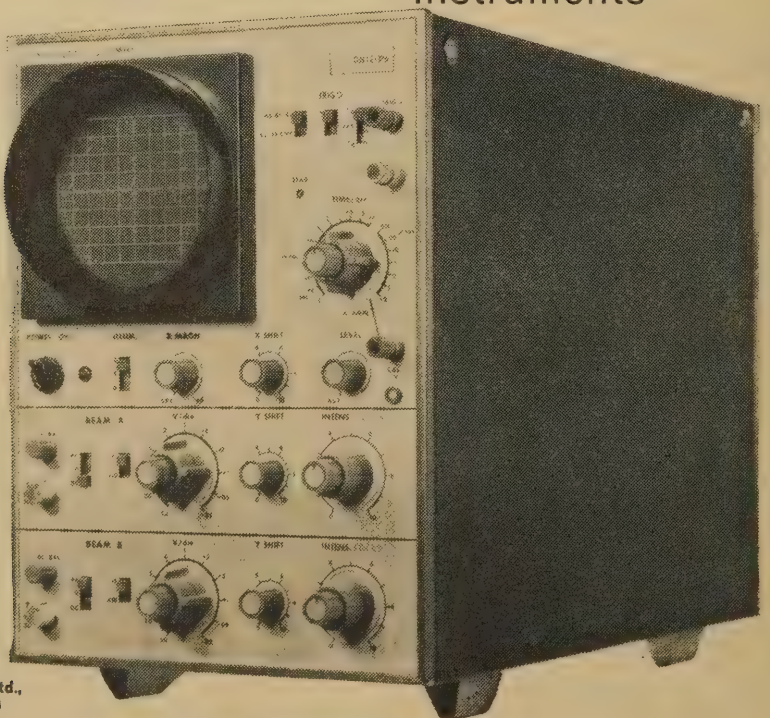
Low power consumption (70 W) and wide range of supply frequencies (50 - 400 c/s), making it suitable for use with an inverter

Facility for photographic recording, three preset levels of graticule illumination for simple camera setting

All components easily accessible for maintenance and repair

PHILIPS

PHILIPS electronic measuring instruments



For the U.K.:
The M.E.L. Equipment Company Ltd.,
207 Kings Cross Road, London WC1

14WW—109 FOR FURTHER DETAILS.

MANUFACTURERS' PRODUCTS

NEW ELECTRONIC EQUIPMENT AND ACCESSORIES

Ultrasensitive Current Meters

A NEW series of ultrasensitive d.c. current meters has been announced by the Greibach Instrument Corporation, of New York. These meters which provide full-scale deflection sensitivities of the order of 200 to 300 nano-amps, without the use of amplifiers or other additional circuitry, incorporate the Greibach Bifilar suspension movement. This provides good stability, repeatability of ± 0.1% and ruggedness combined with low voltage drop. Indication is by means of a light-beam pointer operating over a six-inch scale. Single and multi-range instruments are among the models available, the latter having as many as 23 ranges providing complete coverage of the microampere, milliampere and low ampere current bands. All the models in the 700 range incorporate overload protecton circuits and are available for either for panel mounting or as complete portable instruments. They are distributed in the United Kingdom by the Instruments Division of Claude Lyons, of 76 Old Hall Street, Liverpool 3.

14WW 309 for further details

Instrument Control Knobs

CONTEMPORARY matt-black-finished control knobs in a matching range of three different sizes, are now available from A. F. Bulgin & Co. Ltd., of Bye-Pass Road, Barking, Essex. Moulded from Bakelite, these pointer-knobs are fitted with satin-aluminium flat disc inserts, or spin discs to order. They all feature the Bulgin locked insert, which is positively locked and keyed to the moulding and locked to component shafts by means of a 4 B.A. grub screw (or an Allen type on request). All three are suitable for use on quarter-inch shafts with or without flats.

14WW 310 for further details

Oscilloscope Calibrator

A PORTABLE oscilloscope calibrator, which provides in one unit all the waveforms necessary for the alignment of Telequipment and a number of other makes of scope, has been introduced by Telequipment Ltd., of 313 Chase Road, Southgate, London, N.14. It is a portable instrument with four separate outputs which provide a square wave switched at either 100 kc/s or 1 Mc/s; a square wave switched at either 10 kc/s or 1 kc/s; time marker pulses at switched rates of 1 Mc/s, 100 kc/s, 10 kc/s, 1 kc/s 50 c/s and a timing comb (negative-going with respect to earth); and a non-interlaced television waveform (switched ±ve, with approximately 200 lines, with a combined sync and video amplitude of one volt peak to peak). The calibrator known as the Type C1, incorporates a crystal-controlled source with an accuracy of 0.2% and has an overall power consumption of around 90 watts. It weighs 24 lb and measures 13 × 6½ × 13 in.

14WW 311 for further details

Electrolytic Range Extended

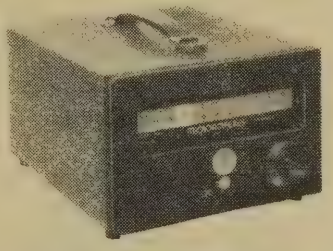
TWO new can sizes have been added to the Mullard Type C426 range of electrolytic capacitors which now runs to 48 types housed in six can sizes. Capacitor values range from 0.64 μF to 500 μF, with working voltages from 2.5 V to 6.4 V. At the same time as introducing the two new can sizes, the manufacturers announce that a higher voltage capacity product and volume efficiency have been obtained and also that these techniques will be used in a new range of electrolytics designated C437.

Thirty-two types comprise the new range, housed, according to their capacity and voltage rating, in cans of four different sizes. Capacitance values are from 64 μF to 4,000 μF with working voltages ranging from 2.5 to 64 volts. The revised C426 range and the new C437 range will be available from 1st January.

14WW 312 for further details

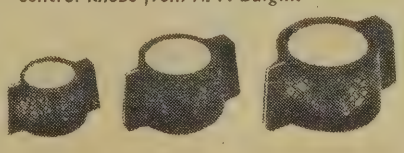
Tunable V.H.F. Amplifier

A MEASURING instrument which offers more possibilities than its name suggests is the Rohde & Schwarz Type ASV tunable v.h.f. amplifier. It covers the whole of the v.h.f. band, that is to say 30 to 300 Mc/s, and a few of the uses it can be put to are: v.h.f. signal generator, audio signal generator, frequency meter, frequency converter, a.m. and f.m. demodulator, a.m. modulator and of course a v.h.f. receiver; with the output on telephone jacks. One of the instrument's accessories is a mixer and harmonic generator, which can be used for frequency multiplication as well as to provide a wide range of harmonics below, in and above the v.h.f. band of frequencies. A wide-band three-stage tunable amplifier is used in the v.h.f. section and operates as a linear



Greibach Model 700 microammeter.

Type K 482, K 483 and K 484 instrument control knobs from A. F. Bulgin.



Telequipment oscilloscope calibrator.

amplifier on input voltages of up to 10 mV, whilst higher input voltages are progressively limited. In operation as a generator, the first amplifier stage functions as an oscillator while the other two stages provide for both amplification and buffering. This v.h.f. output can then be modulated internally or externally. A 1,000 c/s generator delivers the internal modulation voltage, which is also available at an output after amplification in the final modulation stage. The instrument will operate from any 115/ 125/ 220/ 235 volt 50 to 60 c/s supply, and is available in the United Kingdom from Aveley Electric Ltd., of South Ockendon, Essex.

14WW 313 for further details

Low-frequency Wave and Spectrum Analyser

COVERING a frequency range from 1 c/s to 5,000 c/s, the new Quan-Tech 304 spectrum analyser can be electronically swept through the frequency spectrum at three different speeds with bandwidths of 1 c/s, 10 c/s or 100 c/s. The speeds are 18 seconds, 3 minutes and 30 minutes per sweep. A d.c. output, proportional to the frequency at which the instrument is tuned, of 1 mV/cycle, is provided for plotting the spectrum of the input signal on an X-Y pen recorder or an oscilloscope. Sensitivity is quoted as 30 μV to 100 volts full scale with an accuracy of $\pm 5\%$.

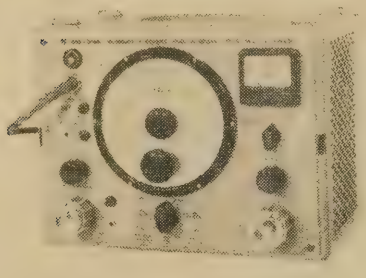
This instrument may also be used as a wave analyser by manually tuning the frequency range. It is available in the United Kingdom through Livingston Laboratories Ltd., of 31 Camden Road, London, N.W.1.

14WW 314 for further details

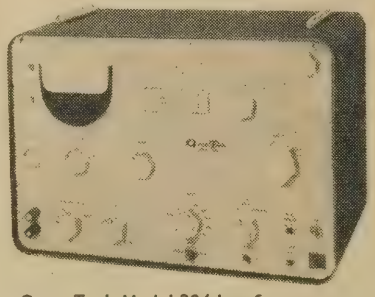
Metal-to-Ceramic Sealed Components

A WIDE range of metal-to-ceramic sealed components is now being made available by EMI Electronics Ltd., of Hayes, Middx. These cover a broad field and include insulators for various parts of microwave valves, high-voltage terminals for plasma research projects and waveguide windows of various shapes and sizes. The company also offers a service for the design and manufacture of special components and will undertake the sealing of customers' parts. A number of metallizing techniques have been developed and the company believes that it can produce a satisfactory bond to the required metal for almost any type of ceramic, bearing in mind that it is necessary to match the thermal expansion of the materials in order to avoid residual strains. In addition to being able to withstand very high temperatures, these components are claimed to possess excellent resistance to thermal shock.

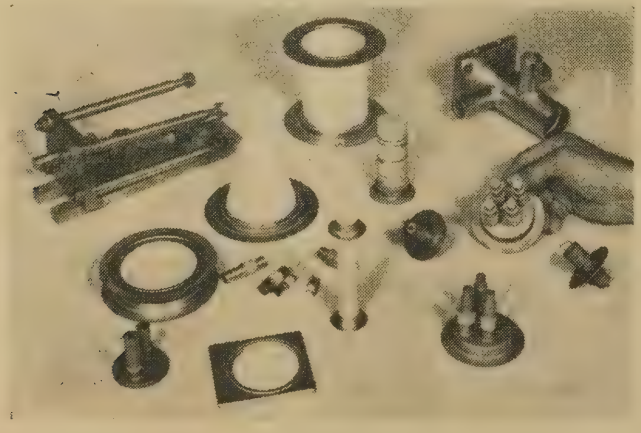
14WW 315 for further details



Rohde & Schwarz 30 to 300 Mc/s tunable v.h.f. amplifier.



Quan-Tech Model 304 low-frequency wave and spectrum analyser.



A selection of metal-to-ceramic components manufactured by EMI Electronics Ltd.

Helical Potentiometer

THREE-QUARTER-INCH diameter helical potentiometers manufactured by Reliance Controls Ltd., of Relcon Works, Sutherland Road, Walthamstow, London, E.17, are now available in five- and ten-turn versions. Various improvements have been made to the series, known as the HEL 07, and the end stop torque has been increased to 5 lb/in. Both the five- and the ten-turn versions are in production with standard linearities of $\pm 1\%$ or $\pm 0.5\%$; or $\pm 0.25\%$ to special order. The resistance range covered is from 10 ohms to 50 kΩ, and a slide wire version is available for lower values up to 1.5 ohms. A three-turn version is to be added to the series later in the year and will incorporate the improvements of the other two, which include a new method of bush mounting and a re-designed wiper with a floating spring action.

14WW 316 for further details

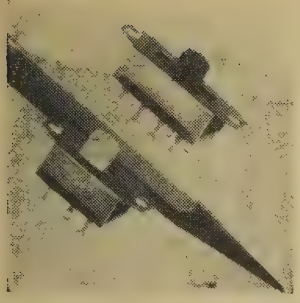
Pulse Generator

A GENERAL-PURPOSE pulse generator, known as the Model 6613, is the first of a new series of British-made test equipment being manufactured by Texas Instruments Ltd., of Bedford. This unit provides coincident positive and negative output pulses at a rate which can be determined either manually or by the internal clock generator or an external signal source. The repetition rate of the clock generator can be varied, in six decade stepped ranges, from 15 c/s to 15 Mc/s. Output amplitude can be varied from zero to 10 volts (into 50 ohms) and a protection circuit is provided against overload. The pulse width is variable up to 90% of the duty cycle. Printed circuit board techniques are used and the instrument measures only $8\frac{1}{2} \times 8\frac{1}{2} \times 12$ in and weighs 10 lb.

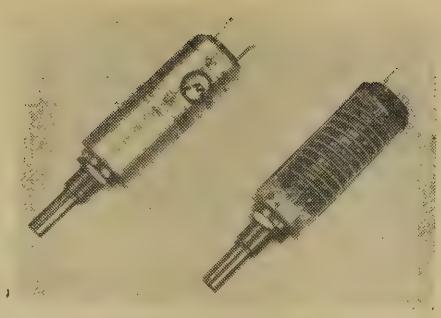
14WW 317 for further details

High-voltage Silicon N-P-N Transistors

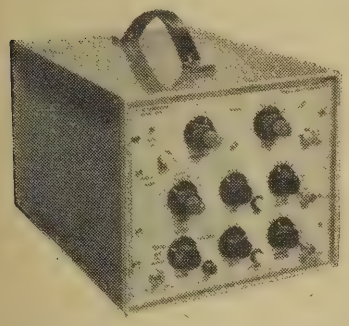
FOUR new triple-diffused, high-voltage silicon transistors for low-power amplifier, oscillator and low-current switching applications have been announced by R.C.A. Great Britain Ltd., of Lincoln Way, Wind-



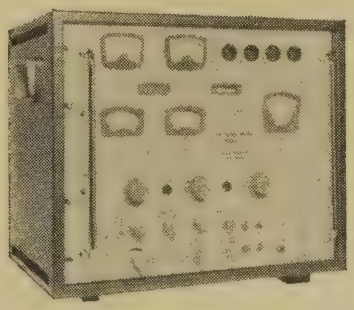
Miniature slide switches from Highland Electronics Ltd.



Helical potentiometers from Reliance Controls Ltd. The one on the right has been cut away to show its construction.



General purpose pulse generator from Texas Instruments Ltd.



Type 331/C frequency meter and generator from J.A.C. Electronics Ltd.

mill Road, Sunbury-on-Thames, Middx. They all have low saturation voltage and fast response characteristics and thus should find many uses in the high-voltage fields such as inverters, regulators, differential and linear amplifiers, etc. Two of the new units, the 2N3439 and the 40255, have a one amp rating with a maximum collector-to-base voltage of 450 V, whilst the other two units, the 2N3440 and the 40256, have a one amp rating with a collector-to-base maximum of 300 volts. The maximum collector-to-emitter voltage for the first two is quoted at 350 volts and a hundred volts lower for the latter two, with an emitter-to-base voltage of 7 V maximum for all four.

The Type 2N3439 and the 2N3340 are housed in standard JEDEC Type TO-5 cases, and the other two are housed in the new diamond flange version of the TO-5 case, which feature increased heat dissipation.

14WW 318 for further details

Miniature Slide Switches

APPROXIMATELY one third the volume of standard slide switches is claimed by Highland Electronics for their new range of single and double-pole miniature slide switches. Two and three position units with detent or spring return mechanisms are included in the new range which is obtainable from 26-28 Underwood Street, London, N.1. The contact rating for these units is quoted at 500 mA at 120 volts, and the minimum insulation resistance is given as 100 MΩ after 48 hours in an environment of 95% humidity at 50°C. The dielectric strength is tested at 900 volts a.c. for one minute between contacts and frame.

14WW 319 for further details

U.H.F. Transistor with A.G.C. Characteristics

GOOD forward a.g.c. characteristics are claimed for the Type AGC/1 silicon planar amplifier transistor from S. G. S. Fairchild, of 23 Stonefield Way, Ruislip, Middx. At current levels up to about 3 mA the characteristics of this unit are similar to the Type 2N918 u.h.f. amplifier transistor, but when the collector current is further increased linear reduction suddenly begins and a reduction in gain of 30 dB is obtained with 9 mA on the collector. This should, therefore, enable i.f. and r.f. amplifiers to be built without the previous limitations imposed such as current starvation or reverse a.g.c. The transistor can be operated with a constant collector voltage and this, of course, keeps the collector capacity constant and avoids detuning of the circuit at different signal levels.

14WW 320 for further details

Frequency Meter and Generator

THE frequency meter and generator Type T.D.1. from J.A.C. Electronics Ltd., (formerly Telemac-Southern Ltd.) of Station Estate, Blackwater, Camberley, Surrey, is now replaced by a new model, known as the 331/C, of improved layout and design. The general electrical characteristics of the instrument remain the same, hence the range as a frequency meter is 10 kc/s to 3,000 Mc/s and as a frequency source from zero to 3,000 Mc/s. Reference standard stability is quoted as ± 5 parts in 10^{10} at constant ambient temperature with better than ± 1 part in 10^9 drift per day. Whereas the T.D.1. had a frequency counter as an optional extra, this is now an optional deletion and provides a reading accuracy of ± 1 cycle as against ± 10c/s. Built-in facilities include automatic harmonic identification, direct measurement of drift about any set frequency, provision of 37,000 standard frequencies (at 10 kc/s intervals) phase locked to crystal accuracy, and the facility of amplitude modulating the output at 1,000 kc/s. Another feature of this instrument is that it has a standard 19in front panel.

14WW 321 for further details

INFORMATION SERVICE FOR PROFESSIONAL READERS

To expedite requests for further information on products appearing in the editorial and advertisement pages of *Wireless World* each month, a sheet of reader service cards is included in this issue. The cards will be found between advertisement pages 16 and 19.

We invite readers to make use of these cards for all inquiries dealing with specific products. Many editorial items and all advertisements are coded with a number, prefixed by 14WW, and it is then necessary only to enter the number(s) on the card.

Readers will appreciate the advantage of being able to fold out the sheet of cards, enabling them to make entries while studying the editorial and advertisement pages.

Postage is free in the U.K., but cards must be stamped if posted overseas. This service will enable professional readers to obtain the additional information they require quickly and easily.

RECENT TECHNICAL DEVELOPMENTS

Laser Developments from Bell

The highest continuous power so far obtained from gas lasers is claimed by Bell Telephone Laboratories. A power output of 1 watt, a tenfold increase over previous gas lasers, has been measured from a helium-neon laser at 6,328 angstroms.

Low-loss mirrors and a tube length of 5.5 metres contribute to the relatively high output of the laser, which requires an input power of 500 watts.

Experiments designed to investigate the problems of communicating by light beams have revealed that light power fluctuates randomly in all kinds of weather, due to minute inhomogeneities in the atmosphere. In rain, attenuation reaches 30 dB; in fog and snow it can be as high as 80 dB. As a result it may be necessary to transmit the light beams through pipes and recently gas lenses have been invented which will guide the light beams in pipes, having the advantages that losses are much less than conventional optical components and curved transmission lines are more feasible.

One lens structure consists of a gas-filled pipe inside which is a helix that heats the gas to a few degrees above the pipe. This causes the index of refraction to rise in the centre of the pipe, and focuses the beam. Focal length is adjusted by the helix temperature.

Our front cover shows two 10 mW lasers in action, one being at a distance of 1½ miles. The 10-point star is only indirectly a quality of the laser light; it is caused by diffraction at the edges of the camera lens iris!

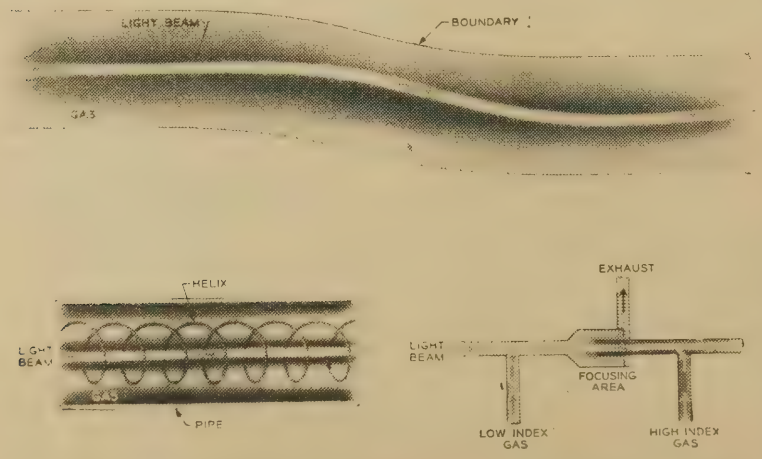
Electrothermal Recording on Plastic Films

It has long been known that images can be formed by the interaction of electrostatic charges with deformable insulating layers. The Eidophor projection television system is a good example. Permanent recording on solid dielectrics has also been reported.

Further developments in the art were described in *R.C.A. Review* (June 1964) where N. E. Wolff describes a method for recording on photoconductive thermoplastics layers. Corona charging with a line or dot screen is necessary to obtain grey shades between black and white and development is accomplished by heating the film to the softening temperature at which point the electrostatic and surface tension forces combine to form undulations which set on cooling. The image is then viewed through the medium of a schlieren projection system.

In the same issue, F. H. Nicholl describes a new surface phenomenon which has been applied to image recording. When a surface layer ranging in thickness from 10Å-1000Å depending on the material, is added to a thermoplastic (polystyrene for instance) corona charging and subsequent heating results in deformation.

Half-tone effects can be obtained without the use of a screen and it is possible to view images by reflected or transmitted light using either conventional or schlieren projection.



Two types of Bell Telephone Laboratories lenses that use differences in the refractive indices of gas to focus and guide light beams. The diagram on top shows how the gas focusing principle may be used to guide a laser beam through a pipe.

Infra-red Fault Detection

A fast-scanning infra-red microscope that can locate failures before they occur in electronic space devices without long, complex tests is being developed by the Raytheon Company under a NASA contract.

Because virtually all potential causes of failure in a semiconductor device or integrated circuit result in abnormal thermal behaviour, use of the so-called Performance Analyzer (which can detect minute amounts of heat) is believed to be one of the most practical ways of testing and predicting the reliability of micro-circuits.

The infra-red detector measures the heat dissipated when a component or circuit is operating. By comparing the heat pattern with a standard, the engineer can determine performance and discover the presence of hidden defects which might lead to failures. It is intended that later models will use a computer memory bank to store test results so that reliability of parts can then be checked automatically.

Transistor with Million Megohm Input Resistance

The thin-film transistor described by P. K. Weimer in *Proc. I.R.E. June, 1963* had an input resistance of 1 MΩ and an input capacitance of 50 pF and oscillation was obtained up to 17 Mc/s. It consisted of a glass substrate on which a gold "source" and "drain" were deposited and semiconducting cadmium sulphide deposited between and on the source and drain. A gold "gate" was insulated from the sulphide by a thin layer of silicon monoxide.

Mullard Ltd. announce progress in

this field with M.O.S.T.—metal oxide silicon transistor—a somewhat unfortunate title since it can be construed that the transistor contains a metal oxide. A p-type silicon substrate is used (this is connected to the TO-5 envelope and can be used as a modulation electrode) on which the closely spaced n^+ source and drain are diffused. A thin silicon oxide layer is then grown on the substrate and acts as a dielectric between this and the evaporated aluminium gate. The device, designated 95BFY, is claimed to have no storage effect and to have the following characteristics:—

Input resistance	$10^{12}\,\Omega$
Input capacitance	4 pF
Output resistance	40 kΩ
Output capacitance	3 pF
g_m 1mA/V at 1_d=3mA	

This data may differ from later samples as development progresses, but fuller details and samples can be obtained from the manufacturers for evaluation purposes.

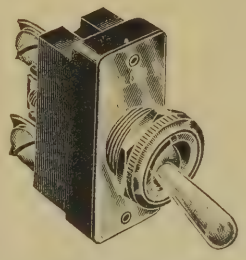
High Energy Discharges for Crushing

The discharging of energies of the order of a megajoule stored in capacitors charged to 40 kV for the production of plasma in thermonuclear reactions was reported in an article in *Wireless World, August 1964*. Inductances as low as 3 μH and a total lead resistance of 0.2 milliohm were achieved. The A.E.R.E. at Harwell have used similar methods to produce underwater plasma giving shock waves of an intensity approaching that of chemical explosives. The shock waves have been used for crushing materials such as gravel, glass, carbides and oxides which are difficult to crush by conventional methods. To obtain maximum effect a short discharge time and low inductance is required. With a capacitor of 0.05 μF charged to 50 kV through 50 MΩ at 1 mA, and an inductance of 0.1 μH (giving a ringing at 3 Mc/s) discharge times of 0.075 μsec to peak and 1.5 μsec total have been obtained. Tempered silver steel electrodes ground to a point have been found most satisfactory and wear is about 1 mm/1000 pulses. (The number of pulses required depends on the material and particle size required: for instance 100 pulses at 35 kV on pellets of UO_2 10 mm × 10 mm reduced size 50% below 0.4 mm). Crushing efficiencies are 30 times higher than those obtained by previous workers on comparable electrohydraulic systems with inductances of 30 μH.

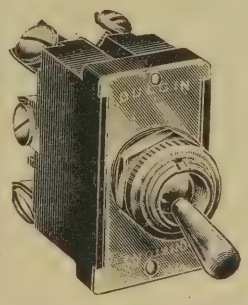
"The Choice of Critics" REGISTERED TRADE MARK

THE HOUSE OF BULGIN
AT YOUR SERVICE

CRITICAL ENGINEERS HAVE HAD CONFIDENCE FOR OVER 40 YEARS IN
BULGIN TOGGLE SWITCHES
THE LARGEST RANGE AVAILABLE



List Nos: S.790-S.797
SINGLE POLE



List Nos: S.780-S.787
DOUBLE POLE

★ SIXTEEN MODELS AVAILABLE
★ THREE POSITION CENTRE-OFF TYPES
★ FINE SILVER CONTACTS
★ MOULDED INSULATION
★ BRILLIANT CHROME DOLLIES & NUTS
★ 2 K.V. PROOF-TEST AT 50 A.C.
★ SMOOTH ROCKER ACTION
★ 6-10A. 250 VOLTS A.C.
★ SOLDERING TAGS OR TERMINALS
★ DELIVERY GENERALLY FROM STOCK
★ COMPETITIVE PRICES

MILLIONS IN USE ALL OVER THE WORLD

DOUBLE OR SINGLE POLE
CHANGE OVER OR MAKE & BREAK
THREE POSITION MODELS
BIASED OR UNBIASED
TAGS AVAILABLE FOR AMP. CONNECTORS

SEND FOR SWITCH LEAFLET NO. 1509/C

A. F. BULGIN & CO. LTD.,
Bye Pass Rd., Barking, Essex.
Tel: RIPpleway 5588 (12 lines)

MANUFACTURERS AND SUPPLIERS OF RADIO AND ELECTRONIC COMPONENTS TO
ADMIRALTY · MINISTRY OF WORKS · B.B.C.
WAR OFFICE · MINISTRY OF AVIATION · G.P.O.
AIR MINISTRY · MINISTRY OF SUPPLY · I.T.A.
HOME OFFICE · RESEARCH ESTABLISHMENTS · N.P.L.
CROWN AGENTS · U.K.A.E.A. · D.S.I.R.

14WW—142 FOR FURTHER DETAILS.

NOVEMBER MEETINGS

Tickets are required for some meetings: readers are advised, therefore to communicate with the society concerned.

LONDON

2nd. I.E.E. & R.Ae.Soc.— "N.A.S.A. research and technology programmes in space navigation" by J. I. Kanter at 5.30 at Savoy Place, W.C.2.

3rd. I.E.E.—"The problem of vestigial-sideband transmission and reception" by W. Wharton and B. J. Rogers at 5.30 at Savoy Place, W.C.2.

4th. I.E.E.—"A push-pull parallel aerial system for navigation and application to communication problems with simple methods of side-lobe cancellation" by Prof. E. O. Willoughby at 5.30 at Savoy Place, W.C.2.

4th. I.E.R.E.—"U.H.F. television reception over long-distance paths" by B. W. Osborne at 6.0 at the London School of Hygiene, Keppel St., W.C.1.

4th. B.K.S.—Symposium on "Underwater cinematography and television" at 7.30 at Shell-Mex House, Strand.

6th. Television Soc.—"Factors affecting the acceptability of colour reproduction" by Dr. R. W. G. Hunt at 7.0 at I.T.A., 70 Brompton Rd., S.W.3.

10th. I.E.E. — "Computer-aided study of character recognition" by J. A. Weaver at 5.30 at Savoy Place, W.C.2.

11th. I.E.R.E.—Papers on "Electromechanical filters" at 6.0 at the London School of Hygiene, Keppel St., W.C.1.

12th. I.E.E.—"Pressure sensitive effects in semiconductors" by K. Preece, P. Lundberg, P. Selway and Dr. V. G. Tull at 5.30 at Savoy Place, W.C.2.

12th. Radar & Electronics Assoc.—"Televising the Tokyo Olympics" by L. F. Mathews at 7.0 at the R.S.A., John Adam Street, W.C.2.

17th Soc. of Relay Engrs.—Papers on transistor repeaters for h.f. and v.h.f. relay systems, by W. Dougharty and A. Isaacs at 2.30 at 21 Bloomsbury Street, W.C.1.

18th. I.E.R.E.—"An air surveillance radar system" by R. L. Burr and J. Flounders at 6.0 at the London School of Hygiene, Keppel Street, W.C.1.

18th. B.K.S.—"Radiophonics" by C. Booker at 7.30 at Central Office of Information, Hercules Road, S.E.1.

19th. Television Soc.—"A British video tape recorder" by J. L. E. Baldwin at 7.0 at I.T.A., 70 Brompton Road, S.W.3.

23rd. I.E.E.—"Loop gain and return difference of transistor amplifiers" by R. F. Hoskins at 5.30 at Savoy Place, W.C.2.

25th. I.E.R.E. & I.E.E.—Discussion on "Symbols for logic circuits" at 6.0 at the London School of Hygiene, Keppel Street, W.C.1.

25th. Inst. Eng'g. Inspection.—"Inspection in the radio and electronics industry" by J. C. McCullagh at 7.30 at South-West Essex Technical College, Forest Road, E.17.

25th. B.K.S. — "Deformation of gramophone record grooves" by D. A. Barlow at 7.30 at Shell-Mex House, Strand, W.C.2.

27th. R.S.G.B.—"Moonbounce" by P. K. Blair at 6.30 at I.E.E. Savoy Place, W.C.2.

30th. I.E.E. & I.E.R.E.—Discussion on "Medical applications of lasers" at 5.30 at Savoy Place, W.C.2.

ABERDEEN

11th. I.E.E.—"Loudspeakers" by K. F. Russell at 7.30 at Robert Gordon's Technical College.

BASINGSTOKE

26th. I.E.R.E.—"Colour television transmission systems" by W. Wharton at 7.30 at Technical College.

BIRMINGHAM

25th. I.E.E.—"Television in the service of technical education" by J. Scupham at 6.15 at the College of Advanced Technology, Gosta Green.

25th. Television Soc.—"Transcoding from SECAM to N.T.S.C." by H. Steele at 7.0 at the College of Advanced Technology.

BRISTOL

18th. I.E.R.E. & I. Prod. Engrs.—"Quality and reliability" by D. J. Hewitt at 7.0 at the University Engineering Laboratories.

26th. I.E.E.—Faraday Lecture on "Colour television" by F. C. McLean at 6.0 at Electricity House, Colston Avenue.

CAMBRIDGE

3rd. I.E.E. & I.E.R.E.—"Integrated circuits" by J. S. Walker at 8.0 at the Engineering Lab., Trumpington St.

26th. I.E.E.—"Through communications to electronics" by G. G. Gouriet at 8.0 at the Engineering Laboratory, Trumpington Street.

CARDIFF

11th. I.E.R.E.—"Automobile electronics" by R. A. Evans at 6.30 at the College of Advanced Technology.

CHELMSFORD

30th. I.E.E.—"The digital computer—how it works and its impact on the solution of engineering problems" by P. S. Brandon at 6.30 at the Lion and Lamb Hotel.

CHIPPENHAM

10th. I.E.E.—"Connections in electronic circuits" by G. W. A. Dummer at 6.0 at the Concert Hall, Westinghouse Brake & Signal Co.

DUNDEE

12th. I.E.E.—"Loudspeakers" by K. F. Russell at 7.0 at the Electrical Engineering Dept., Queen's College.

EDINBURGH

3rd. I.E.E.—"Lasers, what they are and what they do" by N. Forbes at 6.0 at the Carlton Hotel, North Bridge.

11th. I.E.R.E. & I.E.E.—"Signal processing filters and networks" by D. J. H. MacLean at 7.0 at the University, Drummond Street.

EVESHAM

26th. I.E.R.E.—"U.H.F. broadcasting and BBC-2" by D. B. Weigall at 7.0 at the B.B.C. Club.

GLASGOW

11th. I.E.E.—"Electronic instruments and medicine" by I. W. Stevenson at 6.0 at 39 Elmbank Crescent.

12th. I.E.R.E. & I.E.E.—"Signal processing filters and networks" by D. J. H. MacLean at 7.0 at 39 Elmbank Crescent.

LEEDS

24th. I.E.E.—"Newton and Heaviside in control" by G. G. Gouriet at 6.30 at the Electrical Engineering Dept., the University.

LEICESTER

10th. Television Soc.—"Outside broadcasting" by Barry Edgar at 7.15 at Vaughan College, St. Nicholas Street.

12th. I.E.R.E.—"Education and training for professional radio and electronic engineers" by A. J. Kenward at 6.30 at the University.

LETCHWORTH

4th. Inst. Eng'g. Inspection.—"Applications of electronics in metrology" by B. S. Pearn at 7.15 at the College of Technology.

LIVERPOOL

9th. I.E.E.—"Silicon diodes" by R. A. Reid at 6.30 at the Royal Institution, Colquitt Street.

MANCHESTER

4th. I.E.R.E. & I.E.E.—"Television receiving aerials at u.h.f." by C. F. Whitbread at 6.0 at Reynold Building, College of Science and Technology.

17th. I.E.E.—"Cybernetics" by Prof. J. C. West and Dr. J. L. Douce at 6.15 at the College of Science and Technology.

NEWPORT, I.o.W.

27th. I.E.E.—"The present state of colour television" by S. N. Watson at 6.30 at the Technical College.

PLYMOUTH

19th. I.E.R.E. & I.E.E.—"Ballistic missile early warning system" by Brian Batt at 7.0 at the College of Technology.

PORTSMOUTH

4th. I.E.R.E.—"The application of radar and other electronic techniques to meteorology" by W. A. Grinstead and A. P. Tuthill at 6.30 at Highbury Technical College, Cosham.

PRESTON

11th. I.E.E.—"The results of tests at Goonhilly with the experimental earth satellites Telstar and Relay" by F. J. D. Taylor, W. J. Bray and R. M. White at 7.30 at the Harris College of Further Education.

SHEFFIELD

4th. I.E.R.E. & I.E.E.—"Environmental testing of electronic equipment" by K. C. Davies at 6.30 at Dept. of Electrical Engineering, the University.

SOUTHAMPTON

10th. I.E.E.—"A microcircuit logic system" by Dr. D. J. Truslove at 6.30 at the University.

13th. Inst. Electronics.—"Applications of threshold logic" by Lt. W. Sudweeks, R.N., at 7.0 at Grosvenor House, Cumberland Place.

SWANSEA

24th. I.E.E.—Faraday Lecture on "Colour television" by F. C. McLean at 6.30 at Brangwyn Hall.

WHITBY

10th. I.E.E.—"Engineering and scientific aspects of the Canadian ionospheric satellite" by E. D. R. Shearman at 7.0 at Botham's Cafe, Skinner Street.

NOW...

another milestone in audio engineering BY

LEAK

STEREO 30

Transistorised **INTEGRATED AMPLIFIER**

Dimensions: 13ins. x 4¼ins. x 9ins. deep. Weight: 14lbs. **Price £49 10s 0d.**

. . . superb styling, faultless performance and a breakthrough in price and reliability by LEAK . . . the First Name in High Fidelity

Reprinted from "WIRELESS WORLD" Editorial May 1963 ". . . Last autumn, during his presidential address to the British Sound Recording Association, H. J. Leak demonstrated a prototype high-quality transistor amplifier which gave results indistinguishable from those of his valve amplifiers . . ."
"People sometimes ask why there is any necessity to change to transistors. The elimination of the output transformer is, in our view, sufficient reason now that solutions of the problem of linearity in the response of the rest of the transistor circuit have been found. As additional bonuses we get smaller size, cooler running and the prospect of longer life."

Compared with its equivalent valve amplifier the "Stereo 30" gives results which are indistinguishable and it offers these important advantages:

- It is 48% of the weight.
- It is 43% of the size.
- It is 89% of the price.
- It has greater reliability (estimated to be 500% better) because the heat rise within the case is negligible (12°F) and because the maximum voltage is less than 50.

How can the valve possibly survive in view of the above comparisons?

Write now for fully illustrated brochure.

LEAK

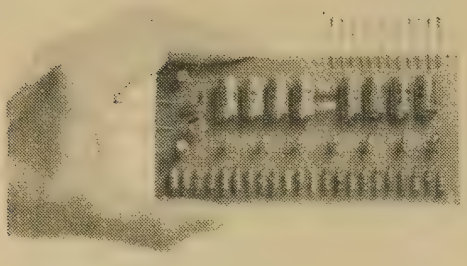
H. J. LEAK & CO., LTD.

BRUNEL ROAD, WESTWAY FACTORY ESTATE, LONDON, W.3.

Telephone: SHEpherds Bush 1173 *Telegrams: Sinusoidal Ealux, London*

14WW—110 FOR FURTHER DETAILS.

SINCLAIR X-10



a radical departure from conventional design

The Sinclair X-10 is a high fidelity integrated power amplifier and pre-amp using 11 transistors and having a transformerless output of 10 watts for feeding into a 15 ohm loudspeaker system. It requires only the addition of tone and volume controls plus a twelve volt D.C. power supply to make it a complete mono high fidelity assembly of exceptional quality. Stereo is achieved by using two X-10 amplifiers and ganged or separate controls. Input sensitivity is sufficient for all crystal or magnetic pick-ups and the manual supplied with the X-10 gives detailed instructions for connecting the controls and for using the amplifier in a wide variety of applications.

This radically new transistor amplifier (patents applied for) is the first to be marketed anywhere in the world using the pulse width modulation principle (P.W.M.) as described by D. R. Birt in "Wireless World," February, 1963. This technique permits an enormous reduction in the power dissipation in the output transistors of an amplifier; and in the case of the Sinclair X-10, the output efficiency is about 95% as compared with about 60% for conventional class B output stages. Thus the dissipation is only $\frac{1}{8}$th or less of that occurring in all other amplifiers. That is why no heat sink is required for the output stage, why small high frequency transistors can be used in place of the conventional low frequency power transistors and why the X-10 will operate from two 4/- batteries with normal use for about 3 months.

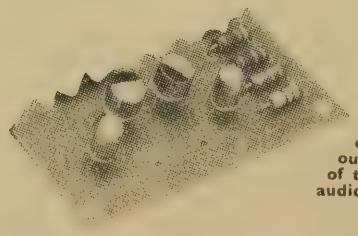
NEW DESIGN, PRINCIPLES, PERFORMANCE

Price, inclusive of all parts and Instruction Manual for building X-10 **£5-19-6**

READY BUILT AND TESTED *including Instruction Manual* **£6-19-6**

Mains Power Supply Unit (A.C. 200/240V) **£2-14-0**

will power one or two amplifiers.



UNIQUE 4 TRANSISTOR OUTPUT STAGE

Another Sinclair special feature—these 4 output transistors do not get hot even at full output because the circuit converts almost 100% of the power from battery or mains unit into audio power for the loudspeaker.

If you do not wish to cut coupon from page, please mention "Wireless World" Nov. when writing.

GUARANTEE *If you are not completely satisfied with your purchase (we are confident you will be delighted) your full purchase price will be refunded instantly and without question.*

FULL SERVICE FACILITIES ALWAYS AVAILABLE TO SINCLAIR CUSTOMERS.

To SINCLAIR RADIONICS LTD., COMBERTON, CAMBRIDGE COMBERTON 682

Please send items detailed below:— £ s. d.

.....

.....

.....

.....

TOTAL £

for which I enclose CASH/CHEQUE/MONEY ORDER

NAME .....

ADDRESS.....

.....

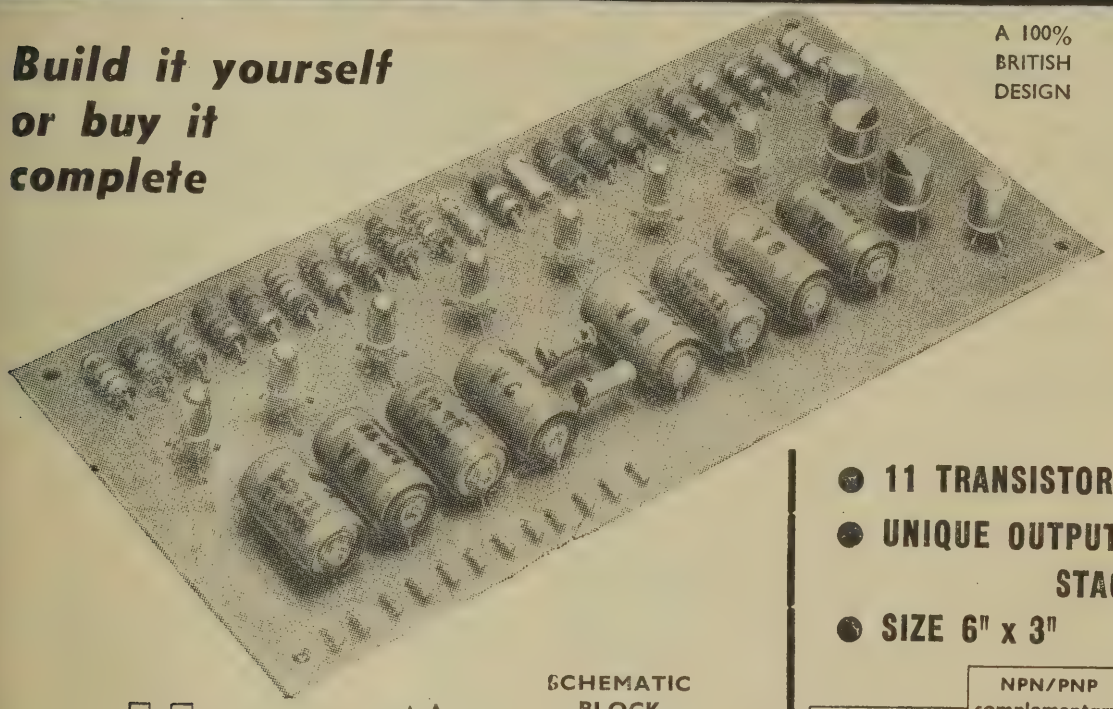
..... WW.11

14WW—111 FOR FURTHER DETAILS.

10 WATT INTEGRATED AMPLIFIER USING PULSE WIDTH MODULATION

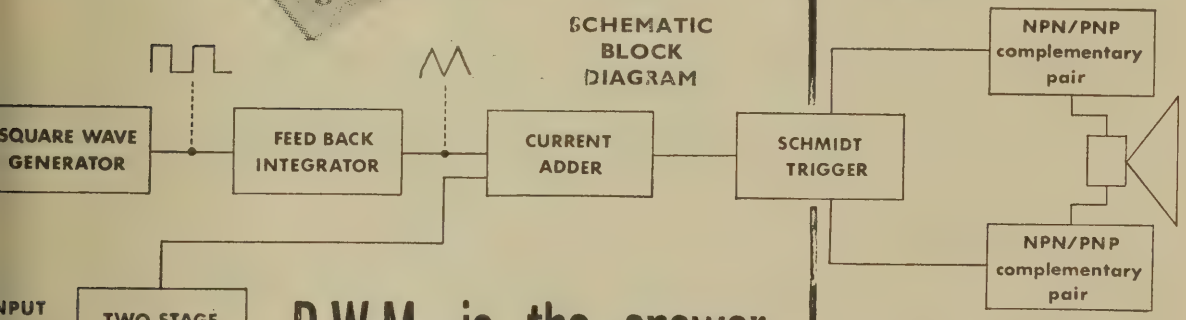
Build it yourself or buy it complete

A 100% BRITISH DESIGN



- 11 TRANSISTORS
- UNIQUE OUTPUT STAGE
- SIZE 6" x 3"

SCHEMATIC BLOCK DIAGRAM



P.W.M. is the answer

The principle is briefly as follows: A square wave of constant voltage amplitude and with a frequency, in this case, of 50Kc/s is applied to the terminals of the load. As the load has a high impedance at this frequency negligible current flows through the voice coil of the speaker.

In the absence of any input signal, the mark space ratio of the square wave is unity—that is, the current flows for an equal period in each direction. When an input signal is applied, the mark-space ratio changes with the result that there is a net current flowing through the voice coil which deflects the cone. When the input signal is at any frequency up to 20Kc/s the net current is an exact replica of the input signal and is independent of the transfer characteristics of the output transistors. Thus the distortion figures can be incredibly low.

The vital advantage of P.W.M. is that the output transistors act as switches and therefore dissipate negligible power. Because of this we have been able to use 5Mc/s transistors in the output stage of the X-10. These transistors are small and require no heat sink.

- ★ No heat sink
- ★ Add your own choice of tone control circuit
- ★ Input Sensitivity 1mV
- ★ Total harmonic distortion >0.1%
- ★ Output power 10 watts
- ★ Frequency response 5-20,000 c/s ± 0.5dB
- ★ Speaker impedance 15Ω
- ★ Damping factor Greater than 100
- ★ Quiescent consumption 75mA
- ★ Supply voltage 12 to 15 volts

HE SINCLAIR X-10 MANUAL

plains how the amplifier functns and how you can add the rrect tone and volume control tem to suit your precise quirements. A variety of tems is shown, none of which l add more than a few shillings the original cost of your clair X-10 be it for mono or reo.

ORE SINCLAIR DESIGNS ON NEXT PAGE

sinclair

SINCLAIR RADIONICS LTD
COMBERTON, CAMBRIDGE
Telephone: Comberton 682

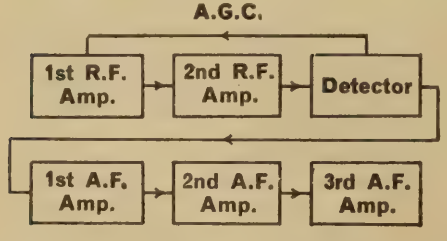
THE SMALLEST SET IN THE WORLD

SINCLAIR MICRO-6
SIX-STAGE RECEIVER

Now more than 9,000 built and in use all over the world

THE 100% BRITISH DESIGNED SINCLAIR MICRO-6 continues unchallenged as the most remarkable receiver of its kind ever made available to the public anywhere in the world. It has special 6-stage circuitry, and is, at the same time, the smallest set on earth. Everything except the lightweight earpiece is contained in the smart, minute white, gold and black case which is appreciably smaller than a matchbox, as the illustration shows. With vernier-type tuning control, bandspread over the higher frequency end of the medium waveband and powerful A.G.C. to ensure fade free reception of the most distant stations, the Micro-6 provides remarkable standards of performance. Quality of reproduction is outstandingly good, and again and again the set is reported to give excellent results where other sets cannot be used at all. The Micro-6 cannot be too highly recommended, both as an intriguing design, to build, and a most practical radio to use.

- **ACTUAL SIZE ($1\frac{4}{5} \times 1\frac{3}{10} \times \frac{1}{2}$)**
- **WEIGHS UNDER 1oz.**
- **BAND SPREAD TUNING FOR EASY RECEPTION FROM LUXEMBOURG.**
- **VERNIER-TYPE TUNING OVER MEDIUM WAVE BAND.**
- **VERY SMART APPEARANCE.**
- **CHOICE OF MANY STATIONS.**
- **BATTERIES AND FERRITE ROD AERIAL CONTAINED IN CASE.**
- **100% BRITISH DESIGN.**



6-STAGE POWER AND SELECTIVITY

The Micro-6 uses *only three* Micro-Alloy Transistors in a unique and very efficient circuit as follows:—Two stages of R.F. amplification are followed by an efficient double-diode detector which drives a high-gain 3-stage A.F. amplifier. Powerful A.G.C. applied to the first R.F. stage ensures fade-free reception from the most distant stations tuned in. Everything including ferrite-rod aerial and batteries is contained within the elegant tiny case.

Easily built in an evening

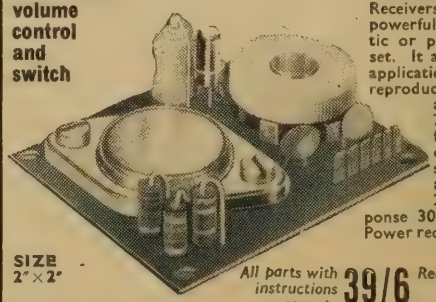
Building is simple and straight forward when the meticulously detailed instructions are followed. All parts including MAT transistors, diodes, printed circuit board, lightweight earpiece, case and dial, and well-printed instructions come to **59/6**

Sinclair "Transrista" well-styled, strong black nylon wrist strap **7/6**

Mallory Mercury Cell Type ZM312 (2 required) each, Pack of 6 ... ... **10/6** **1/1**

SINCLAIR TR750 POWER AMPLIFIER

With built-in volume control and switch



THE TR750 enables the Sinclair Micro-6 or Slimline Receivers to be used as a powerful car radio or domestic or portable loudspeaker set. It also has many other applications such as a record reproducer, intercom or baby alarm. An ouput of 750 milliwatts for feeding into a standard 25-30Ω loudspeaker requires only a 10mV input into 2kΩ. Frequency response 30-20,000 c/s ± 1dB. Power required—9 to 12 volts

SIZE 2"×2"

All parts with instructions come to **39/6** *Ready built and tested with instructions* **45/**

ORDER FORM AND X-10 ON PRECEDING PAGES

UNIQUE SINCLAIR
Guarantee

The following unconditional guarantee applies to everything you buy from Sinclair Radionics Ltd:-

If you are not completely satisfied with your purchase (we are confident you will be delighted) your full purchase price will be refunded instantly and without question.

★ **FULL SERVICE FACILITIES ALWAYS AVAILABLE TO SINCLAIR CUSTOMERS**

SINCLAIR RADIONICS LTD.
COMBERTON, CAMBRIDGE TELEPHONE COMBERTON 682

sinclair

14WW—113 FOR FURTHER DETAILS.

electrosil electronic components – trend setters for industry

TYPE NUMBER	Power Rating	Ohmic Range	Standard Tolerances
TR4	1/10 W @ 70° C 1/4 W @ 70° C 1/2 W @ 70° C	51—150K	5% 2% 1%
TR5	1/4 W @ 70° C 1/2 W @ 70° C 1/2 W @ 70° C	10—470K	5% 2% 1%
TR6	1/2 W @ 70° C 1/2 W @ 70° C 1 W @ 70° C	10—1 M	5% 2% 1%
TR8	1/2 W @ 70° C 1 W @ 70° C 2 W @ 70° C	100—1.4 M	5% 2% 1%

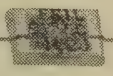
Triple rated metal oxide film resistors

The Electrosil TR range is the most versatile ever available. One resistor may be used at three ratings – semi-precision, high stability and general purpose. Full Qualification Approval has been granted to the TR5 and TR6 at both semi-precision and general purpose ratings and supplies are readily available from bonded stock.

Type P Low Power Insulated Resistors

Power Ratings of 3 to 10 watts at 70°C are covered by the new P range of insulated oxide film resistors. The rugged construction leads to reliable performance across the full ohmic range, and prices are very much less than for comparable vitreous enamelled wire resistors.

CYFM glass capacitors

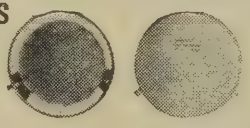


The CYFM range of glass capacitors is of fused monolithic construction in which the capacitive element is completely frozen in glass, with a true glass-to-metal seal at the leads. Values between 0.5 pf and 1,200 pf are covered in two case sizes.

Microcircuits

ectrosil microcircuits consist of re-stors and capacitors deposited on e surface of a specially glazed high ensity alumina substrate. The resis-ve film is identical to that used in e Electrosil range of metal oxide m resistors and the combination of ide film molecularly bonded to a ass surface is already well-known r its stability and reliability.

Digital ultrasonic delay lines



Glass digital delay lines, which use a time invariant glass as a delay medium and either quartz or ceramic transducers, represent a new generation of delay lines. They can be operated at frequencies of 2.5 Mc/s to 30 Mc/s or higher, with access time up to 15 times smaller than a high speed magnetostrictive line of comparable storage.

Glass memories

In terms of cost per bit, they are many times less expensive than cores and only slightly more expensive than drums, and can operate at rates up to 100 mb/s.

Electrosil LIMITED

ELECTROSIL LIMITED

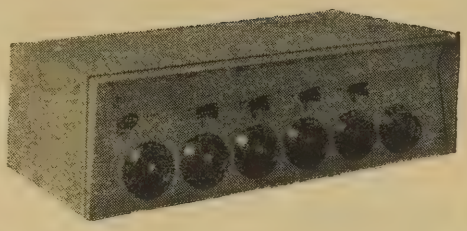
PALLION, SUNDERLAND, CO. DURHAM

Tel: Sunderland 71557 Telex 53273

A43a

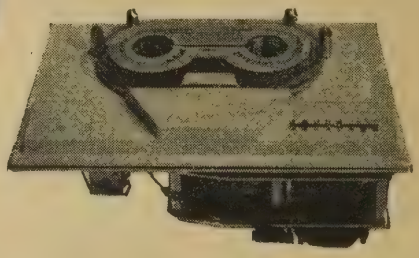
14WW—114 FOR FURTHER DETAILS.

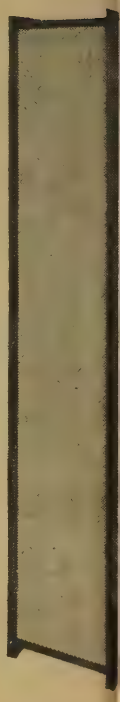
SOUND COVERAGE LTD



can now offer from stock a complete range of P.A. equipment including line source loudspeakers (indoor and outdoor), wedge loudspeakers, column units, transistorised amplifiers and mixers, a special purpose tape deck, and background music machines and music services. Our special products division can quote you for your special requirements.

Catalogue gladly sent on request.



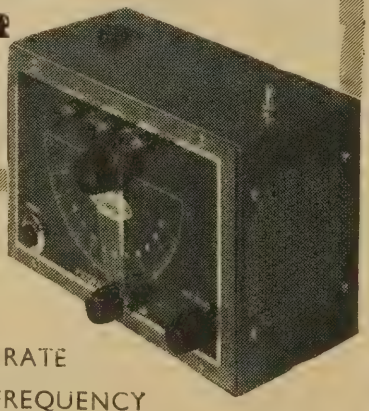


SOUND COVERAGE LTD.,
7/9, KEW GREEN, RICHMOND, SURREY
TELEPHONE RICHMOND 5438

14WW—115 FOR FURTHER DETAILS.

TRANSISTORISED CAPACITANCE METER

0-55 pF
and
0-550 pF



FAST,
ACCURATE
± 3%
SIMPLE TO OPERATE
1.5 Mcs TEST FREQUENCY
AUDIO BALANCE

PRICE ONLY **18 GNS.**

F. C. ROBINSON & PARTNERS LTD
Specialists in Electronic Equipment and Instrumentation

Works & Northern Sales
COUNCILLOR LANE, CHEADLE
CHESHIRE
Telephone GATley 3611 (3 lines)

FCR

Southern Sales & Export
DAVIES HOUSE, 181 ARTHUR RD.
WIMBLEDON, LONDON S.W.19
Telephone WIMbledon 5185

14WW—116 FOR FURTHER DETAILS.

Someone—Somewher
has neve
heard of

HOWELL RADIO

MINISTRY OF AVIATION APPROVED INSPECTION.

TRANSFORMERS
STANDARD RANGE OR TO YOUR DESIGN
TOROIDAL—'C' CORE—PULSE—MATRIX

CHASSIS—CABINETS & PRECISION METALWORK
ELECTRONIC ASSEMBLY

HOWELLS RADIO LTD.
MULBERRY STREET, MANCHESTER, 15
MOSS SIDE 2000-2434

14WW—117 FOR FURTHER DETAILS.

DYNAMIC IS THE WORD

Reslo Pencil Dynamic microphones give dynamic performance... dynamic sound quality

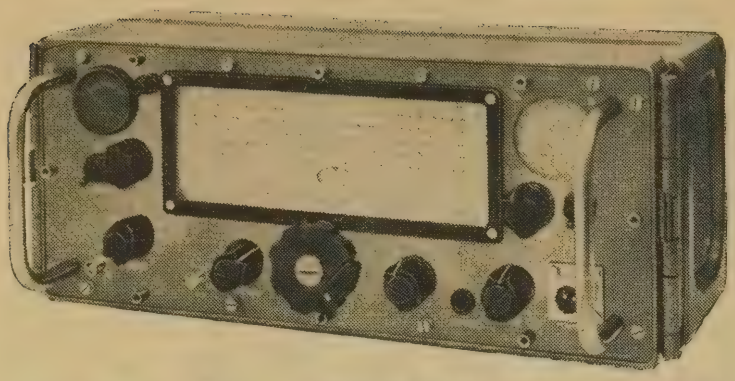
This entirely new Reslo microphone incorporates a miniature dynamic insert and the lightweight cylindrical shell is so designed that its smooth and excellent transient response extends well into the bass region.

These and many other features or the Reslo PD microphone make it eminently suitable for high quality recording and relay purposes. It can confidently be used for high-level realistic close speaking or singing purposes — without additional acoustic filters.

Reslo DERRITRON GROUP

RESLOSOUND LIMITED
24 UPPER BROOK STREET LONDON W.1
TELEPHONE HYDE PARK 2291

14WW—118 FOR FURTHER DETAILS.



this set is unique!

Designed by C & N (Electrical) Limited as a compact, robust, reliable equipment, this sophisticated set stands alone in its field. Whatever the environment, this Receiver will remain operational – powered by standard U2 torch batteries, vehicle batteries, field generator or mains supplies. Tough assignments require dependable equipment.

7020 HF COMMUNICATIONS RECEIVER

FULLY TRANSISTORISED - FREQUENCY RANGE OF 0.5 to 32 Mc/s.

Any portable Receiver offering the detector outputs which this set has available, capable of operating under the most adverse environmental conditions, and designed particularly with hard usage in mind, has so far been cumbersome, unwieldy and unsuitable for prolonged manhandling. This set marks a major step forward in British communication equipment and has been selected for use by the 1964/65 British Combined Services Expedition to South Georgia, Antarctica.

Brief Technical Summary – Crystal calibration at 100 Kc/s intervals. Frequency selection: 11 x 3 Mc/s Bands. Power Supply: Between 12 and 50 V DC at 100 mA (peak). Signal Modes: AM, PM, SSB, FSK, & CW. Co-axial or Wire Aerial connections. Total Weight: 20 lbs. The Receiver is housed in a standard R.A.E. aluminium alloy Equipment Case and has been accepted by the British Ministry of Defence.

C & N (ELECTRICAL) LTD, THE GREEN, GOSPORT, HANTS.
Telephone : Gosport 80221/8. Telex : 8621

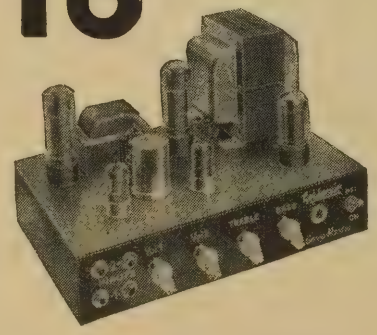
14WW—119 FOR FURTHER DETAILS.

Goldenair

A SUPERBLY DESIGNED HIGHLY SENSITIVE QUALITY AMPLIFIER INCORPORATING A PRE-AMPLIFIER AND TONE-CONTROL STAGES.

"THIRTY" AMPLIFIER

16 GNS.



FULL 12 MONTHS' GUARANTEE
EXCELLENT TRADE TERMS.

SPECIFICATION

A polished black control panel is fitted to the Amplifier with distinctively marked control indications set in gold relief. **SIZE:** Approx. 12in. x 9in. x 9in. Well ventilated metal cover available price 21/-.

TEST FIGURES

FREQUENCY RESPONSE: ± 2 Db. 25-20,000 c/s. Bass Control. ± 12 Db. at 50 c.p.s. Treble Control, + 12 Db. to — 6 Db. at 12,000 c.p.s.
HUM AND NOISE LEVEL: 70 Db. down.
NEGATIVE FEEDBACK is employed with 20 Db. feedback in the main loop.
SENSITIVITY: 12 millivolts for full output, thus being suitable for any type of mike or pick-up.
POWER OUTPUT: 30 watt.
POWER CONSUMPTION: Approx. 150 watts.
MAINS SUPPLIES: A.C. 200/230/250v., 50 c/s. A reserve power supply is provided for radio feeder or tremolo unit if required.
OUTPUT MATCHINGS for 3 and 15 ohm speakers.
MULLARD VALVES: One GZ34, one ECC83, two EF86, two EL34.

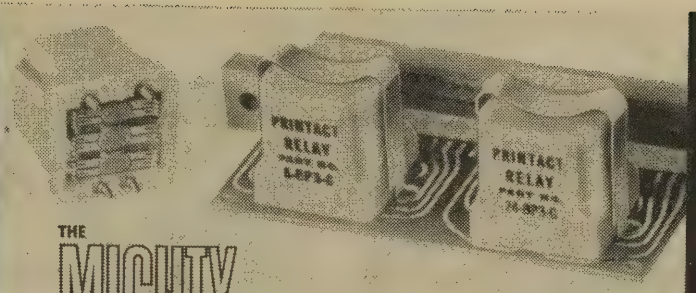
Trade and Export Enquiries to:

EON PRODUCTS LTD.

EON WORKS 164 TOWN STREET RODLEY YORKSHIRE Tel. 34703

14WW—120 FOR FURTHER DETAILS.

PRINTED CIRCUIT RELAY



THE MIGHTY MIDGET

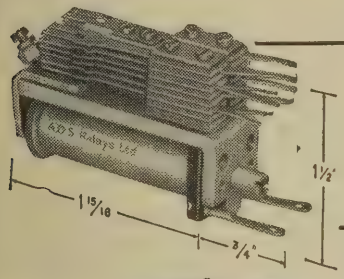
G & R and LATCHING RELAYS

Operate Volts 6, 12, and 24 volt D.C. will pull-in occurring at 80% of rated voltage. Variations of coil resistance are available on special order.

Operating life exceeds 5,000,000 operations when contact load is from dry circuit up to ¼ amp. 24 volts D.C.

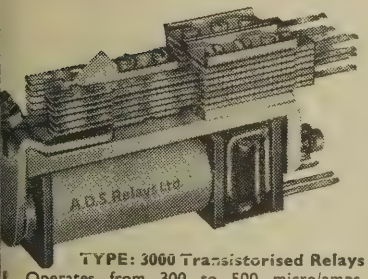
Contact Material	Gold alloy or Palladium
Power Consumption...	500 m/w (at rated voltage)
Operating Temperature	−30° C to +95° C at rated voltage
Operate Time	3 to 7 m/s. See Table II
Dimensions & Weight	⅞in. x ⅞in. x 1 3/16in.—0.8 oz.
Dielectric Test	1,000 volts RMS 60 cps.

Other Printact features include Bifurcated contacts; Double-break contacts; Balanced armature; Enclosed housing; Plug-in application; Encapsulated coil; Self-wiping contacts; Inherent snap-action, greater switching versatility.



S1500 RELAY

A.C. or D.C. Operating. Coil up to 10,000 ohms. Single or double winding. Contact Material—Silver, Platinum. Spring set—6 change-overs. Light Duty Maximum. Fixing same as 600T Relay. Standard or Tropical finish. Dimensions—length 2 1/16in. Height 1½in. Width ¾in.



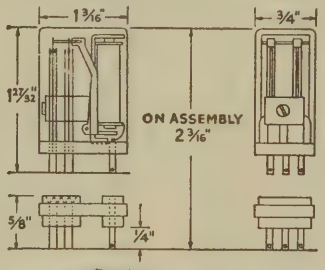
TYPE: 3000 Transistorised Relays

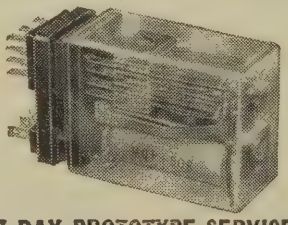
1 Operates from 300 to 500 micro/amps. at 1½ volts D.C.

2 Operates from 3 to 5 micro/amps. at 1½ volts D.C. Maximum contacts 2 change-overs light duty or 2 change-overs heavy duty.

3 Operates from 15 to 30 micro/amps. at 1½ volts D.C. Maximum contacts six change-overs light duty.

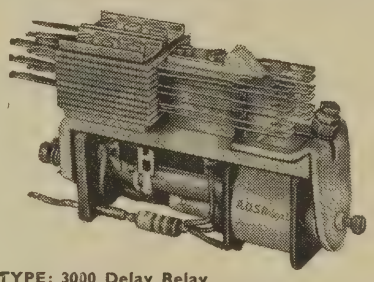
MINIATURE PLUG-IN RELAY
Operate D.C. Volts 6 to 100. Operate Time 6 m/s. Release Time 4 m/s. Twin Contacts. Temp.: −10° C to +40°C. Mounting rack can be supplied for 36 Relays P.O. 19in. x 3½in. These racks can be cut to any size.
Quantity up to 10 at 16/- each.
Further discounts according to quantity.



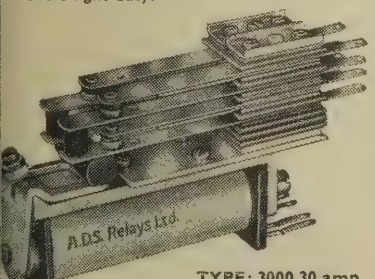


7 DAY PROTOTYPE SERVICE

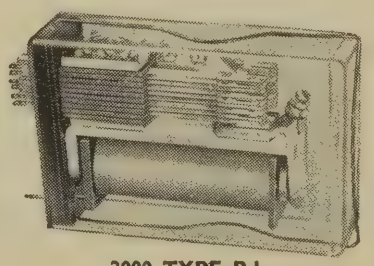
A.I.D., A.R.B.
ADMIRALTY APPROVED



TYPE: 3000 Delay Relay
This relay can be supplied with operate-delay up to 25 seconds from supply of 6 to 50 volts D.C. Release delay up to 25 seconds with trigger circuits to 1½ volts D.C. Energised from 6 to 50 volts D.C. Contacts maximum 6 change-overs light duty.
With adjustable resistor giving plus or minus 2 seconds of nominal figure on operate and release relays.



TYPE: 3000 30 amp.
Capable of carrying 30 amps. 250 v. A.C. with maximum build up of 4 makes 4 breaks. Coil: .1 to 80,000 ohms.



3000 TYPE P.I.
Plug-in Relay

A. D. S. RELAYS LIMITED

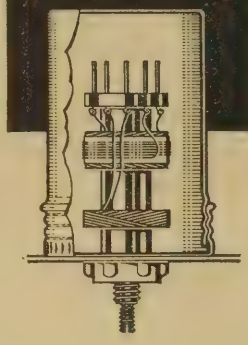
89-97, ST. JOHN STREET, LONDON, E.C.1. Tel.: CLErkenwell 3393/4/5

14WW—121 FOR FURTHER DETAILS.

LATEST HIGH QUALITY COMPONENTS FROM THE MAXI-Q RANGE .....

TESTED AND TRIED OVER 5 FREQUENCY RANGES

TRANSISTOR TUNING COILS



★ Coils for transistor superhets or converters, with or without an R.F. stage and using 465 Kc/s or 1.6 Mc/s. I.F.
★ Noval B9A Based for Plug-in application—Screw threaded for Chassis application.
★ Formers moulded in low-loss polystyrene for best results.
★ Each coil is packed in an aluminium container which may be used as a screening can.
★ Brass threaded adjustable iron-dust cores.

The following colour code identifies the coils:

BLUE	— Aerial coil with base input winding.	PRICE
YELLOW	— Interstage R.F. coil with couplings.	4/9d. each.
RED	— Oscillator coil for 465 Kc/s. I.F.	
WHITE	— Oscillator coil for 1.6 Mc/s. I.F.	

Stop Press 3 Pole 3 Way 3 Bank Switch. 7s.6d. each. I Pole 8 Way 4s.3d.

Coverages: Range 1T—.15/.4 Mc/s; 2T—.515/1.545 Mc/s; 3T—1.67/5.3 Mc/s; 4T—5/15 Mc/s; 5T—10.5/31.5 Mc/s.

Full technical details in Technical Bulletin DTB.4—1/6d.

IFT.13 Miniature 465 Kc/s. I.F. Transformer..... 7/6d. each
IFT.14 Miniature 465 Kc/s. Last I.F. Transformer .. 7/6d. each
IFT.16 Miniature 1.6 Mc/s. I.F. Transformer ..... 6/6d. each
IFT.17 Miniature 1.6 Mc/s. Last I.F. Transformer .. 6/6d. each

GENERAL CATALOGUE covering full range of components, send 1/6d. in stamps. PLEASE SEND S.A.E. WITH ALL OTHER ENQUIRIES.

DENCO (CLACTON) LTD., (DEPT. W.W.), 357/9 Old Road, Clacton-on-Sea, Essex

TRANSVERTERS

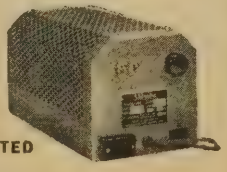
(TRANSISTORISED D.C. CONVERTERS)

2 KW. Peak Starting. 650 W. Continuous. 50-60-400 c/s. or D.C. from 12-24-50 v. Battery. Up to 93% Efficiency. Polarity Reversal Protection. Square or Sinewave. Up to 300% Instant Overload Capacity. Manually Controlled Frequency. Reed Type Indicator. Remote Control Facilities.

Applications: Static "No-Break" Standby Power Supplies: For Vital System(s) Protection, e.g. V.H.F. Transmitters: Industrial Processes; Control-Alarm-Warning Systems: Mobile Use of Counters; Sig./Gen. Recorders—U/V Sound. Oscilloscopes and Lab. Gear in Marine and Aircraft (K114).

Range of models available with prices from £11-£90.

Please write to department C.10 for transverter leaflet.



Valradio LIMITED

the D.C. conversion specialists since 1935

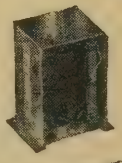
BROWELLS LANE . FELTHAM . MIDDLESEX
Telephone: FELTHAM 4837

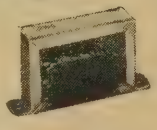
Valradio and Stereosonoscope are the registered trade marks of Valradio Ltd.

14WW—122 FOR FURTHER DETAILS.

LARGE REDUCTIONS IN PRICES OF COMPONENTS FOR OLDER MODELS

...VAST SELECTION OF TV REPLACEMENT COMPONENTS FOR ALL MODELS!





ALWAYS OBTAINABLE FROM STOCK: Time Base Components, 405/625 & 625 line Line Output Transformers, Chemicals for Servicing, Capacitors, Resistors, Rectifiers, Test Equipment, etc., etc. Retail enquiries S.A.E., Trade enquiries on headed paper.

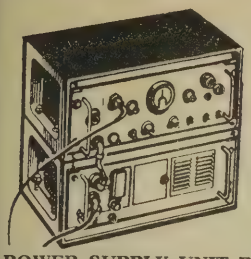
Order on SAME DAY SERVICE

from

direct TV Replacements LTD.

Dept. WW, 126 Hamilton Rd., West Norwood, London, S.E.
Telephone: GIPsy Hill 6166 (PBX)

14WW—123 FOR FURTHER DETAILS.



CARRIER FREQUENCY SHIFT ADAPTOR. This modern equipment of recent manufacture is in excellent condition and suitable for operation with most Service Receivers. IF frequency adjustable internally 445-475 kc/s. The adaptor will operate two independent Teleprinters. Power supplies A.C. mains 230 v. or 24 v. D.C. Price **£12/10/-**, Carr. 25/-.

POWER SUPPLY UNIT PN-12B. Ex BC 640, 230 volts A.C. input, fits 19in. rack, 800 volts D.C. @ 350 ma., 395 volts, 300 ma., 4 × 5U4G valves, 2 chokes 9 H., 300 ma., 2 × 10 mfd. oil filled caps, **£6/10/-** each, carr. £1.

RELAY UNIT. G.P.O. 600 types 5 relays 150 ohm 1 set C/O., and 5 relays 400 ohm 2 M., 1 set C/O, in metal box 8×6×5 inches, **£2**, post 5/-.

AR88 SPARES. 14 valves, headphones and 3 pilot lamps, new original cartons, **£3/10/-** each, post 2/6.

FACSIMILE KEYER UNIT KY 75 SRT, 115/230 volts, **£25** ea.

MODULATOR MD 168/UX (for the above keyer), **£12/10/-.**

SMALL GEARED MOTOR, 24 volts D C. 70 r.p.m., **19/6**, p. 2/-

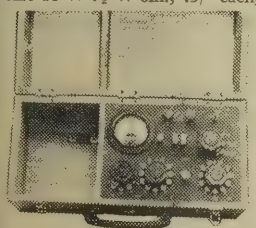
SIGNAL GENERATOR 1-196A. Freq. range 100-156 mc/s. Power requirements 115 v. A.C. or batteries. **£3** each. Carr. 15/-.

AR88 PORTABLE KITS. Fine, well-made box for the receiver and spares with original speaker. Vibrator unit 6 volt D.C., 14 valves, lamps, headset, shock mounts, cables, brand new, **£7/12/6,** carr. 25/-.

METERS. 0-60 amps, centre zero 6in. scale, proj. m.c. **17/6** each, 5/- post. 0-150 amps., centre zero 6in. scale, proj. m.c. (requires external shunt), **17/6** each, 5/- post. 0-100 amps., 6in. scale, A.C./D.C., **30/-** each, **6/6** post. 90-180 v., A.C./D.C., 4in. scale, **£1** each, 5/- post.

BC-221 or LM 13. Freq. meter complete with original charts in good working order. Range 125 kc/s.-20 Mc/s., **£16/10/-,** carr. 15/-.

WHEATSTONE BRIDGE in a beautiful oak case, centre zero galvanometer 2.5 mA., 4 stud switches, 0-10, 0-100 ohms, 0-inf., size 16 × 7½ × 6in., **45/-** each, 5/- post.



SIGNAL GENERATORS

TS.13AP. 115 v. A.C. freq. 9305-9445 mc/s. complete with valves 723/AB and waveguide, tuning, etc. **£7/10/-,** 25/- carr.

TF.144G. 230 v. A.C. 85 kc/s.-25 mc/s. In excellent condition **£16/10/-** ea., 25/- carr.

UPM 1a. Combined Test Set for checking radar installation. 2 wavemeters, 155-235 mc/s. 460-570 mc/s. Signal Generators 155-235 mc/s. and 460-570 mc/s. Also Video Amplifier and Oscilloscope complete in one unit. 115/230 v. A.C. **£35,** carr. £2 (new).

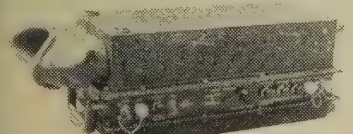
TS.12AP. Standing Wave Indicator Equipment. Complete with Amplifier and waveguide plumbing equipment, **£12/10/-** each, 15/- carr.

TS.36AP. Power Meter, with accessories, used for checking radar outputs, **£5** each, 10/- carr.

804 Signal Generator. Freq. 7.5-330 mc/s. in 5 bands. Power supplies 115-230 v. A.C. In excellent condition, **£25,** carr. £1.

TF.338/B. Variable Attenuator. Variable 0-25 db. switched 20, 40, 60, 80 db, 600 ohms input and output, **£3** each, post 6/-.

AR88 SPEAKER. New, **£3/10/-,** carr 5/-. **AR88 VIBRATOR UNIT,** new, **17/6,** carr. 6/6.



TRANSMITTER/RECEIVERS, for export only, available in bulk quantities.

WIRELESS SET No. 88, No. 31, No. 38, C.52, complete installations can be quoted for. Please write for further details.

TS-34 PORTABLE SINGLE BEAM OSCILLOSCOPE

Viewable Waveforms.	30 c/s. to 1 mc/s.
Cathode Ray Tube.	2in. screen magnified to approx. 4in.
Input Voltage, Low Impedance	0.1 to 1 volt.
High Impedance, 0db.	0.1 to 1 volt.
20db.	1 to 10 volts.
40db.	10 to 100 volts.
Input Impedance.	low—62 ohms. high—430 ohms/30pF.
Time base, single stroke	5-50-250 microseconds.
continuous.	10 to 50,000 c/s.
Internal Calibrating Pulses.	1 microsecond intervals.
A.C. Main Voltage.	115 v.

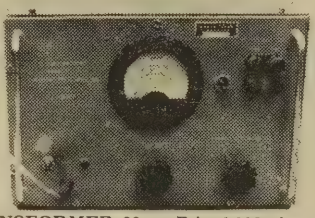
Dimensions: 6in × 8in. × 15in. oscilloscope alone, Weight: 26lbs. 29in. × 9¾in. × 10in. carrying case, Weight: 16lbs.
In excellent condition, price **£15,** repairable condition £9, carr. 15/-.

DE-ICER, Controller Mk. 3. Contains 10 relays D.P. changeover heavy duty contacts, 1 relay 4P, C/O (235 ohms coil) Stud switch 30-way relay operated, one five-way ditto, D.C. timing motor with Chronometric governor 20-30 volts 12 RPM, geared to two 30-way stud switches and two Ledex solenoids, 1 delay relay, etc., sealed in steel case, size 4 × 5 × 7in., **£3** each, post 5/-.

BC640 MODULATOR UNIT. 2 × 811's, mod. transformer and fil., trans. complete mod. unit fits 19in. rack 50 watts, **£5/10/-.** carr. £1.

TRANSFORMERS (Isolation). 230 to 115 volts 300 va., **£3** each, 5/- post. 230-115 volt auto. 750 watts **£4,** carr. 10/-. 110-230, 275-0-275 at 125 ma., 6.3 at 4 amps. **22/6** each, post 5/-. 230 v. 6.3 v., x 3 at 3 amps. **21/-** each, post 4/-. 230 v., pri. 1850-0-1850 at 500 ma., **£5** each, carr. 15/6. 230 v., pri. 6.3 x 3 at 3 amps. **20/-** each, post 4/-. Pri., 110/230 v. input 7.5 v. at 4 a., 2.5 v. at 5 a., 7.5 v. at 8 a., 6.3 v. at 4 amp., **25/-** each, 5/- post. 230/115 v. auto. 300 va. **£2,** post 6/6.

MARCONI V.H.F. VOLTMETERS TF428-B/1 Ranges: 0 to 1.5, 5, 15, 50 and 150 volts. Fitted with probe unit for RF measurements. 230 v. mains input Brand new, **£12/10/-** each, carr. 10/-.



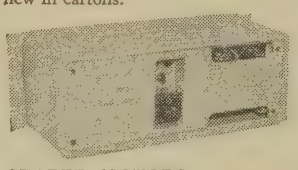
TCS MODULATION TRANSFORMER 20 w. Pri., 6,000 ohm. C.T. Sec., 6,000 ohm. **25/-** each, post 3/6. **MICROPHONE TRANSFORMER** Pri., 75 ohm. Sec., 125,000 ohm. **10/-** each, post 2/6. **OUTPUT TRANSFORMER.** Pri., 7,500 ohm. Sec., 500 ohm. C.T., 2.5 w. **12/6** each, post 3/-.

GEARED MOTOR. 24 v. D.C., 1.4 r.p.m., reversible with two micro switches inside gear box, silent operation, **£2** each, post 5/-.

POWER SUPPLY unit for SENDER No. 36 110-240 v. A.C. input contains Speech amplifier. Modulator and External power supplies, 3xFW4/500 rectifiers provide H.T. for F.R. unit Speech amplifier 6C5G, Modulator 2x6C5G and 2 × 807 output. Size 24 × 16 × 14 inches Housed in a fine oak case with circuit. Wt. 110 lbs. As new **£6/12/6** carr. 30/-.

CONVERTERS. Type 8 a., 24 v. D.C., 115 v. A.C. at 1.8 amps. 400 cycles, 3-phase. **£5** each, carr. 7/6.

CONDENSERS. 1 mfd., 20 kv., **£6/12/6** each, post 12/6 each. 0.25 mfd., 32,500 volts Wkg. **£5** each, post 12/6 each. 150 mfd., 290 volts A.C. **£5** each, post 12/6. 50 mfd. 330 volts A.C. **40/-,** post 4/-. 10 mfd., 1,000 v. **12/6** post 2/6. 8 mfd., 1,500 volts **17/6,** post 2/-. 8 mfd., 1,200 volts **12/6** post 3/-. 8 mfd. 600 volts, **8/6,** post 2/6. 0.25 mfd. 2 kv. **4/-,** post 1/6. Vacuum condenser 50 pf. 32 kv. **30/-,** post 1/6. 6 pf. 20 kv. **22/6,** post 1/6. All the above are new in cartons.



POWER & SMOOTHING UNITS. 100-250 v., A.C. input 24 v., D.C. at 3 amps. or 12 v. twice at 3 amps., continuous rating, switched fused, etc. In metal case 19 × 7 × 7in. Smoothing two large chokes and 0-1 ma. meter scaled 0-50 volts. **£7/10/-** (pr.), 15/- carr.

GEARED MOTORS

20-30 v. D.C. 72 r.p.m., **17/6,** post 2/6.
28 v. 150 r.p.m., **25/-,** post 2/6.
24 v. Open gears with governor, approx. 10 r.p.m., **25/-,** post **2/6.** (The above types are reversible)

POWER FACTOR CONDENSERS. 160 mfd., 290 v. A.C. working. **£5/10/-** each, carr. 10/-.
4 mfd., 12,500 v. D.C. working, **£7/10/-** each, carr. 15/-.

POWERSTAT VARIAC. Type 1126. Pri. 115 v., 50-60 cys. Output 0-135 v. @ 15 amps. **£8/10/-** each, carr. 15/-.

HEADPHONES. DLR 5, **12/6** pr., No. 10 Headset, with microphone, **15/-** pr. Post 2/6.

BLOWER MOTORS. 24 v. D.C. (small U.S.A.), **12/6,** post 2/-. Med. sized Blower Motor, 115 v. D.C., **30/-** each, post 3/6.

TELEPRINTERS, Type 7B. Used condition, **£12/10/-** each. Carr. £1.

FSK UNIT, Type 2 (ATE Ltd.). **£12/10/-** each, carr. £1.

OSCILLOSCOPES. Cossor 1035, **£30.** Hartley Type, 13A, **£25.** Solartron Type CT518, **£20.** Carriage on all three £1.

SPECIAL RECEIVERS. ARN.21 or 9171 (Tacan equipment). ARC 52 Rec./Trans. (Please write further details.)

TX DRIVER UNIT 100-156 mc/s. Ideal for two meters, Valves 3C24, in excellent condition, fits 19in. rack, **£5** each, carr. 20/-.

CONTROL UNIT. 230 v. A.C. output 24 v. 2 amps., 230 v. A.C. solenoid switch, 15 amps., plus relays and switches, etc., **£2/10/-,** carr. 12/6.

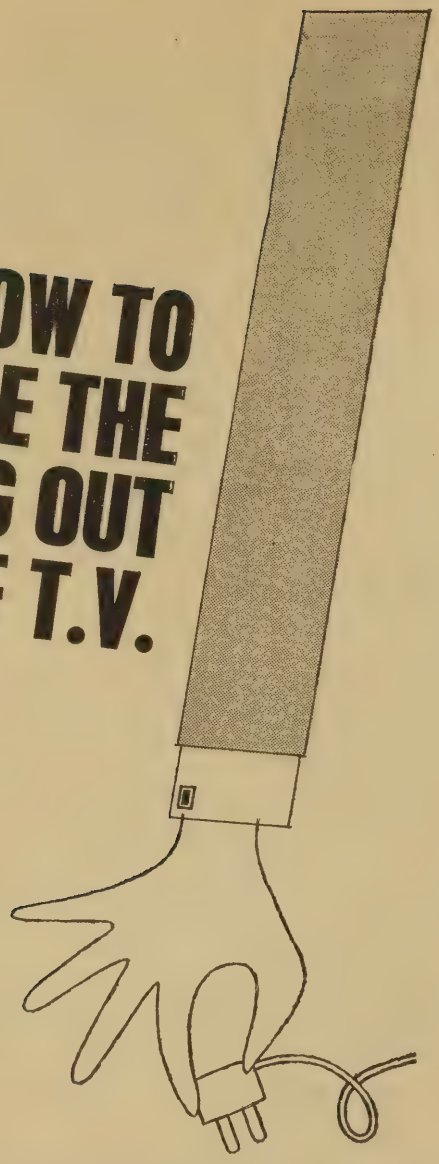
RECEIVERS. HRO. Used condition, less coils, **£10** each, carr. £1. S.36, used condition, freq. 30-143 mc/s. **£25,** carr. £2. S.27/U, used freq. 143-210 mc/s., **£25,** £2 carr. C.52, used, freq. 1.75-16 mc/s., **£5,** carr. £1. H.63 (similar to 1392), 100-156 mc/s., **£5,** carr. £1.

Complete installations can be quoted for. Please write further details List available 6d. S.A.E. for all enquiries.

W. MILLS 3-B TRULOCK ROAD, TOTTENHAM, N.17
Phone: Tottenham 9213 & 9330

14WW—124 FOR FURTHER DETAILS.

HOW TO TAKE THE PLUG OUT OF T.V.



TV sets as portable as transistor radios and running on dry batteries are now possible. The working prototype sets seen by the public for the first time on the Ever Ready stand at the Radio Show, evoked tremendous interest. Their circuits, developed by Ever Ready in conjunction with Thorn Electronics Ltd., are available to any manufacturer interested. Their battery, the Ever Ready TV1 is ready now. Production is geared to meet all market requirements. If you have not yet seen these remarkable sets and batteries Ever Ready's Central Laboratories will be pleased to demonstrate the receivers and supply sample batteries which have many other new applications. Telephone or write for an appointment now to Mr. B. H. Williams, Technical Sales Manager.

EVER READY *Batteries for longer life!*

THE EVER READY CO. (GB) LTD · HERCULES PLACE · HOLLOWAY N7 · ARCHWAY 3030

14WW—125 FOR FURTHER DETAILS.

NUMBER ONE IN ELECTRICAL CONNECTORS... 1

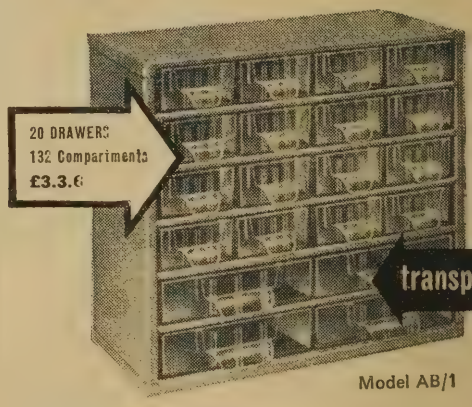
UHF-COAXIAL/TWINAXIAL

General Purpose Coax/Twinax. Six basic shell styles. Up to 500V Peak.

CANNON ELECTRIC (GREAT BRITAIN) LTD.
25-27 Bickerton Road,
Upper Holloway, London, N.19.
Telephone: ARChway 4837

CANNON PLUGS

14WW—126 FOR FURTHER DETAILS.



Model AB/1

It's easy to find small components in an original raaco cabinet

- You can see at a glance what you want
- 6 drawer sizes with movable dividers
- Stout steel frame will carry heavy loads
- Hang them up, or stack them in units
- Range of 25 different space-saving cabinets

FOR MODERN AND EFFICIENT STORAGE OF SMALL ITEMS

raaco LTD *Write today for free illustrated leaflet* Bath House, 57/58 Holborn Viaduct London, E.C.1. Tel: City 3410

14WW—127 FOR FURTHER DETAILS.

AR-88 SPARES

R.C.A. Headphones 12/6
Escutcheons (Widows) 8/6
Knobs. Medium size. Set of 8. 10/–.
Block Condenser (3 x 4 mfd.). 7/6.

CONSTANT VOLTAGE TRANSFORMERS. Input 190 to 260 volts 50 c.p.s. Output 115 volts at 2 kVA. A pair of these will give a constant output of 230 volts at 4 kVA. Price **£15** each, plus £1 carriage. Two for **£30.** Carriage paid.

GENERAL RADIO LR2 HETERODYNE FREQUENCY & CALIBRATOR EQUIPMENT. BRAND NEW. £75.

nstruction manuals for LM-14 Wave-neter. Original. New **32/6.**

Quotations for other Instruction Manuals on receipt of S.A.E.

MILLIAMMETERS

Panel meter 0-1 milliamp. Flush mounting circular. Barrel diameter 2½in., outside diameter 3¼in. Dials are scaled 0-100. Resistance is 75 ohms. Fe & NFe. BRAND NEW. **25/-.** P. & P. 1/–.
Meter Rectifiers (S.E.I.). 1 mA. **6/-.**
Westinghouse 5 mA. **5/-.**

MICROAMMETERS

R.C.A. 0-500 microamps. 2¼in. circular flush panel mounting. Dials are engraved 0-15, 0-600 volts. As used in the American version of the No. 19 set. **15/-.**

FERRANTI OLTMETERS N5.

300 volts, 25-00 c/s. Moving on. 6in. scale. . mtd. Her-etically sealed. ade IN. Made 55. BRAND EW. Boxed /6. Post 4/-.

NDUSTRIAL METER. Iron clad. 0 to 0 v. A.C. 50 cycles. Moving iron, 6in. ale Fl. mtg. BRAND NEW. **59/6.** P. 4/–.

ILOWATT METER 0-16KVA. 6in. ale. Boxed. New. **£5.** P. & P. 6/6.

C. VOLTMETER. 0-300 volts Moving on. Flush panel mounting. Barrel dia-eter. 2½in. **22/6.**

COSSOR DOUBLE BEAM OSCILLOSCOPE TYPE 1035

A modern oscilloscope in good working rder. Fully guaranteed. **£37/10/-.** arr. 30/–.
PARE TUBES for this 'scope. Type 9D. BRAND NEW. **59/6.** P. & P. 4/6.

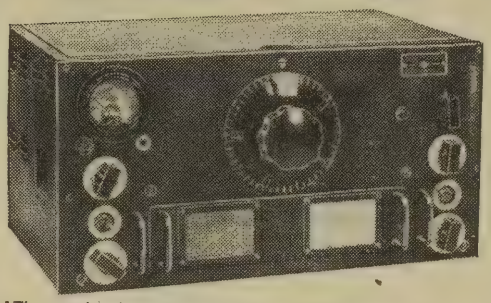
MARCONI SIGNAL GENERATOR F-517. Three ranges. 18 to 58 Mc/s in individually calibrated ranges and 160 to 00 Mc/s. by indirectly calibrated dial. .C. mains operation. **AS NEW CONDITION** in original transit cases ith instruction book. **£7/10/-.** Carr. £1.

STANDARD TRANSFORMERS

acuum impregnated. interleaved, E.S. reen, universal mounting. Size 4 x 3½ x in. ALL BRAND NEW. **18/6** each. ost 2/6.
ype 1. 250-0-250 v. 80 m/a., 6.3 v. 3 a. apped at 4 v. 4 a. 6.3 v. 1 a. tapped at v. and 5 v. 2 a.
ype 2. As above but 350-0-350 v. 0 m/a.
ype 3. 30 v. 2 a., tapped at 12, 15, 0 and 24 v. to give 3-4-5-6-8-9-10 v., etc.
ype 5. 0-6-9-15 v. 4 a. Ideal for hargers.

OVING COIL PHONES. Finest uality Canadian with chamois ear-muffs nd leather-covered headband. With ad and jack plug. Noise excluding and remely comfortable. **22/6.** Post 1/6.
s above but complete with moving coil icrophone. **25/-.** Post 2/6. DLR-5 Low mpedance headphones with attached roat microphone. **12/6.** Post 1/6. All ese items BRAND NEW.

HRO MODEL 5T £30



The octal valve version. Superb condition. Complete with ALL nine general coverage coilsets covering 50 kc/s to 30 Mc/s, instruction booklet and circuit but less external power supply. Carriage 30/–.
POWER UNITS. A.C. mains operation 115/230 volts. **59/6.** P. & P. 4/–.

ABSORPTION WAVEMETERS

MARCONI TF-643B. Covers from 20 to 300 Mc/s. in four plug-in coil ranges. Complete with individual calibration charts. Accuracy 1%. Indication is on a 50μA 2½in. panel meter. In original transit cases. Condition as new **£5/19/6.** Carr. 7/6.

AVO WIDE RANGE SIGNAL GENERATORS Six turret operated ranges covering 50 kc/s to 80 Mc/s For use on standard A.C. mains. Packed in original transit cases with accessories. Post-war type in new condition. **£16.** Carriage 10/–.

L, C & R BRIDGES

AVO, capacity 5 pfd. to mfd. Resistance 5 ohms to 50 Megohms. Inductance can be measured against external standard. Balance is indicated on a meter which can be used as a valve voltmeter from 0.1 to 15 v. Leakage test and Power Factor scale. A.C. mains operation. Tested and guaranteed and in superlative condition. **£9/10/-** plus 5/– P. & P.

MAGNETIC COUNTERS (Ex-G.P.O.). 4 figures to 9,999 Coils 500Ω for 24 v. operation. Tested. (No reset). **5/-** each. P. & P. 1/6. SPECIAL OFFER. 10 for **30/-.** P. & P. 4/–.

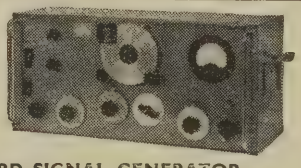
RELAYS G.E.C. MINIATURE SEALED

M–1095. 670Ω 2M 2B H/D Wire Ends	7/6
M–1099. 670Ω 2M H/D Wire Ends	7/6
M–1052. 5,000Ω 2/CO. Plat. Wire Ends	10/–
M–1092 670Ω 4/CO. Plat. Wire Ends	12/6

ALL BRAND NEW AND BOXED. Please add postage.

OSCILLOSCOPE OS-57/USM 38

A modern American instrument with printed circuit, miniature valves (30) and 3in. CRT (3WP1). Rugged construction, handsome appearance, 9in. x 13in. x 14½in. Controls are protected by a detachable lid which neatly houses test leads, cathode follower probe, circuit diagram and instructions. Time base 1, 10, 100, 1K and 10KμS/inch. Markers 1, 10 and 100μS. Features include "X" expansion. Astigmatism, trigger rate 40 to 5,000 c.p.s., Sweep Stability, variable calibration voltage. "Z" modulation, etc. Marker and Trigger pulses can be used externally. Operates from 115 volts 50 to 400 c.p.s. Tested and in BRAND NEW condition. **£29/10/-.** Carr. 10/–.



STANDARD SIGNAL GENERATOR £16/10/-
MARCONI TF-144G/4 Carr. 30/-
Complete and in apparently very good condition but sold as received from the Air Ministry, i.e., untested and less leads. Technical manual and circuit supplied. We assure potential customers that "untested" does NOT mean "beyond economical repair" but are willing to supply GUARANTEED WORKING instruments complete for **£25.**

HEATHKIT & JASON AGENTS

CHARLES BRITAIN (Radio) LTD.

11 UPPER SAINT MARTIN'S LANE
LONDON, W.C.2. *TEMPLE Bar 0545*
Near Leicester Sq. Station. (Opposite Thorn House)
Shop hours: 9-6 p.m. (9-1 p.m. Thursdays). Open all day Saturday

PHASE MONITOR ME-63/U (AN/URM-67)

Designed to measure directly the phase angle between two applied audio frequency signals of from 20 to 20,000 c.p.s. ±1° Direct indication on a panel meter. Input can be sinusoidal or non-sinusoidal from 2 to 30 volts peak. Of recent manufacture (1957) by Control Electronics Inc. and ex-U.S.A. Air Force. In first class condition with handbook. A complex instrument with 19 valves. **£40.** Carriage 30/–.

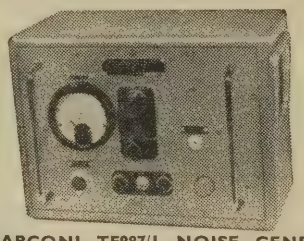
AERIALS VERTICAL 32FT.

Consists of 10 heavy duty screw together rods (3ft. long, ⅝in. dia.) together with a separate 14ft. whip aerial (wired through). Complete with base mounting, all guy ropes, insulators, spikes and even a hammer. All contained in a sturdy canvas carrying bag similar to a gold bag. Full contents list available. BRAND NEW. **59/6.** Carr. 10/6.

HEWLETT PACKARD 205 AG. An American audio signal generator of the finest quality. Ranges 20 to 200, 200 to 2,000 and 2,000 to 20,000 c.p.s. Output is 5 watts. Fully variable attenuator 0 to 110 dB in 1 dB steps. Output impedances 50, 200, 500 and 5,000 ohms CT ungrounded. Input and output monitor meters. Operation from 110 volts A.C. mains. Electrically perfect but wooden cases may be slightly damaged. **£30.** Carr. 30/–.

RADIATION METERS

Portable dose rate meter containing modern type rectangular 50 micro-amp meter CVX 494, electrometer valves, etc. BRAND NEW. In canvas carrying case **£3/19/6.** Post 4/-.



MARCONI TF987/1 NOISE GENERATORS. DETERMINE NOISE FACTOR of A.M. & F.M. receivers. A.C. mains operation. Stabilised. H.T. AS NEW. Tested, **£15,** carr. 7/6. SLIGHTLY USED (but tested), **£8/19/6,** carr. 7/6.

TS-175 HETERODYNE FREQUENCY METER

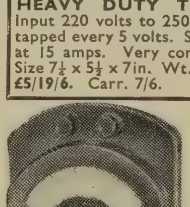
A high frequency version of the well-known BC-221. Accuracy 0.05%. Frequency range 80 to 1,000 Mc/s. As new condition with original calibration book. Tested and guaranteed. **£75.**

SIGNAL GENERATOR CT-53

A precision instrument covering 8.9 to 15.5 Mc/s. and 20 to 300 Mc/s. in six ranges. Variable attentuator from 1μV to 100 millivolts. A.C. mains operation. Good condition, tested and complete with calibration chart. **£16/10/-.** Carr. 10/–.

HEAVY DUTY L.T. TRANSFORMERS (Gresham). Latest type potted, oil filled. Pri. 230 v. 50 c/s. Sec. 0-70-75-80 v. 4 amps. Size 5½ x 4½ x 6½in. high. Wt. 19lb. BRAND NEW. **32/6.** Carr. 5/–.

HEAVY DUTY TRANSFORMER. Input 220 volts to 250 volts at 50 cycles tapped every 5 volts. Secondary, 50 volts at 15 amps. Very conservatively rated. Size 7½ x 5½ x 7in. Wt. 28lb. Brand new. **£5/19/6.** Carr. 7/6.



SANGAMO WESTON VOLTMETERS

561. Dual range 0-5 and 0-100 v. D.C. FSD 1 m/A 3in. scale. Recent manufacture. Ideal for schools. Complete in super quality canvas carrying case, with test prods and leads. **BRAND NEW.** Boxed **32/6.** Post 2/6.

MOST VERSATILE MINIATURE RECORDER

11 SPEEDS WITH ONE MOTOR
With any one drive motor 11 different chart speeds are available by means of rapidly interchangeable gearboxes.

99 CHART SPEEDS
From ½" to 450" per hour on all analog (galvanometer) recorders

RANGES
Models available to record A.C. and D.C. current and voltage and temperature.

BELOW SEA LEVEL TO 100,000'
Performance unaffected by changes in atmospheric pressure.

A.C. or D.C. DRIVE
Chart drive powered by synchronous motors of any standard voltage and frequency or D.C. motors which consume only milliwatts of power.

INSIDE, OUTSIDE
The recorder may be easily weatherproofed, and may be safely used in all weather conditions including high humidity.

NO INK
Smooth high resolution traces are produced without the need for ink, heated stylus or voltage sensitive paper.

LARGE CHART CAPACITY
At 1" per hour a standard chart roll lasts a full month.

EXPERT ADVICE
Our representatives will readily advise you on any application.

BELOW ZERO TO 160°F
2% F.S.D. accuracy maintained over a wide range of ambient temperatures.

ROUGH USAGE
This precision instrument is housed in a rugged die cast aluminium case. Tough, dependable it will give years of faithful service under the most adverse conditions.

LOW COST PRICES FROM £53

RE-ROLL or TEAR OFF
The chart is rewound inside the unit or in the tear off type it feeds out of the recorder and may be torn off as required.

rustrak
WEST Instrument Ltd
A Division of GULTON INDUSTRIES (BRITAIN) LTD.
The Hyde, BRIGHTON, 7, Sussex, England
Tel: Brighton 66271 Telex 87179

in PORTABLE UNITS or for PANEL MOUNT

write or phone for CATALOGUE

14WW—128 FOR FURTHER DETAILS.

VITALITY BULBS

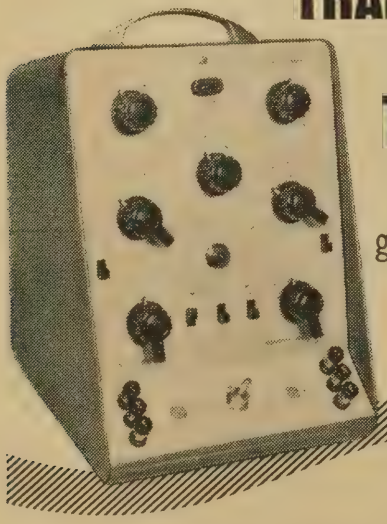
FROM 1V to 50V IN SIZES FROM 4.5mm to 18mm DIAMETER

Tested and proven
Miniature and
Sub Miniature
Indicator Bulbs

Catalogue:
Vitality Bulbs Ltd.
Neville Place,
Wood Green, N.22.
Bowes Park 0016

14WW—130 FOR FURTHER DETAILS.

TRANSISTOR CURVE TRACER



for use with general purpose oscilloscopes

PRICE £110

NPN & PNP TRANSISTORS	DIODES (ZENER, TUNNEL, 4 LAYERS etc.)
V_{CE} versus I_C	V_{BE} versus I_C
I_{CEO} I_{CES} V_{SAT} V_{CEO} & V_{CBO}	FORWARD & REVERSE DIODE CHARACTERISTICS
BUILT IN CALIBRATION FACILITIES	SELECTION OF MATCHED PAIRS

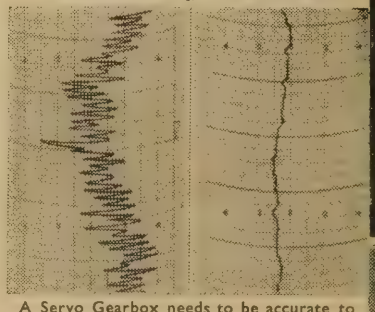
ELLIOTT
Radar & Communication Instruments Division
ELLIOTT BROTHERS (LONDON) LIMITED
Wigton Gardens, Stanmore, Middlesex

A Member of the Elliott-Automation Group

14WW—129 FOR FURTHER DETAILS.

DECIDING FACTOR— 'HAIRBREADTH' PRECISION

MAGN: X 3000 I DIV. =.00002"
STANDARD TOLERANCES | A RECENT RELIANCE GEAR



SEND FOR FREE PRECISION COMPONENTS MANUAL
567 PAGES CONTAINING 20,000 ITEMS

A Servo Gearbox needs to be accurate to the finest limits. That's why Reliance work to well within Admiralty Class I standards. Reliance gears give maximum stability, minimum backlash, dependable operation and interchangeability of ratios and components. Send for FREE 567 page Manual with 20,000 items for easy reference. Every Design and Development Engineer should find out more about the quick, comprehensive and competitive service from Reliance Gear Co. Ltd.

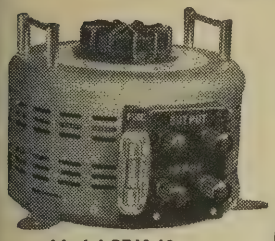
STOCK LEVELS: 265, 844 TO 839, 173 COMPONENTS

RELIANCE GEAR CO. LTD.
ST. HELENS GATE, ALMONDBURY, HUDDERSFIELD. Tel.: 21121/3

14WW—131 FOR FURTHER DETAILS.

NEW TEST EQUIPMENT

VARIABLE VOLTAGE TRANSFORMERS
World famous "SLIDUP"



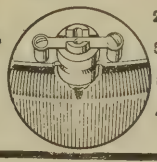
Model SB10 10 amp.

Inset shows latest type brush gear providing 1 volt variation.

★ *RATED CURRENT CONSISTENT AT ALL POINTS ALONG THE WINDING.*

Output: 0-260 v. Input: 230 v. A.C. 50/60~.

Shrouded fully variable transformers for bench or panel mounting.



2.5 Amp.	£5.17.6
5 Amp.	£9. 0.0
10 Amp.	£18. 5.0
20 Amp.	£32.10.0

Ex works.

PORTABLE VARIABLE A.C. POWER SUPPLY UNIT

DESIGNED FOR ENGINEERS WHOSE REQUIREMENTS CALL FOR A VISUAL INDICATION OF VOLTS APPLIED.

OUTPUT: 0-260 v. 1½ amps.

INPUT: 230 v. A.C. 50/60~. Unit fitted with fuse, voltmeter, safety indicator, on-off switch and lead. Size: 8 x 5 x 5in. high.

PRICE **£7.15.0** P. & P. 5/6

MODEL 304B

Price ONLY **£35.0.0**

—no extras.

VALVE VOLTMETER

Latest circuitry provides perfect stability and sensitivity.

Professionally acknowledged

***11 megohms per volt.**
***5mV-1,500 V. A.C.**
***100mV-1,500 V. D.C.**
***0·1 ohm—1,000 megohms**
PLUS
***1 Kc Oscillator Test Source**
***Complete with Test Probe with BUILT-IN A.C./D.C. switch, no fumbling or fiddling with out of reach knobs.**

This superbly finished instrument is invaluable in Production depts. and Labs and is presented in an attractive light grey crackle steel case with satin alloy front. Mains operated. Size and Weight: 5½in. x 3in. x 8in. high. 5½lb.

CONSTANT VOLTAGE TRANSFORMER

AUTOMATIC MAINS STABILIZER

Maintains correct voltage without any seasonal drops. No unstable test gear reading

★ **Perfect stabilization.**
★ **Instant response.**
★ **Absolutely no maintenance.**
★ **No voltage drop in winter.**
★ **No moving parts—no attention.**

COMPLETE WITH LEAD & PLUG IN SILVER HAMMER METAL CASE. EASILY CARRIED ANYWHERE.

Spec.: **INPUT:** 110 and 240 VAC. ± 20%. **OUTPUT:** 240 v. A.C.—50/60 cycles. **CAPACITY:** 250 VA. **ACCURACY:** ±1½%. Size: 10 x 5 x 7in. high. Weighs only 21lb. **WITH SIGNAL LAMP AND SWITCH.**

£11.10.0 carr. 12/6.

IMMEDIATE DELIVERY

ALL ITEMS FULLY GUARANTEED

SUPPLIED COMPLETE WITH VALVES & CRYSTALS
Details & Prices of all Accessories supplied on request.

LATEST miniature WALKIE TALKIE '88' Set

Produced to exacting specifications by leading manufacturers E. K. Cole & Co.

Only

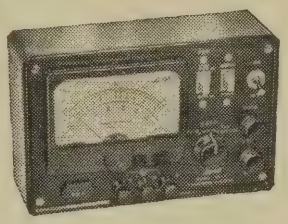
£10.0.0

EACH

This Transmitter /Receiver weighs only 5½lb.(appx.) and measures 3½ x 5½ x 9½in.

A crystal controlled 4 frequency set operates from standard dry battery—H.T./L.T. (i.e. Vidor L5537), 14 current series B7G valves used.

TRANSISTOR TESTER



Model AT-1 **£9.17.6** P. & P. 5/6

FULLY PORTABLE PRECISION INSTRUMENT

MEASUREMENT RANGES:

Ico (Icbo) and the reverse current of diodes.

PNP & NPN—0~50μA (1μA per scale).

POWER—0~1mA (20μA per scale).

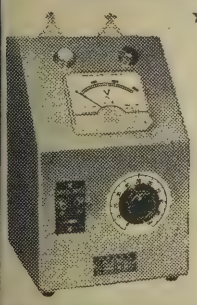
β5-200 (5 per scale)

Bias current—
(1mA on PNP & NPN)
(5mA on POWER)

α0.9-0.995 (from $\beta = \frac{\alpha}{1-\alpha}$)

Terminals : **Spring Sockets and Screw Terminals.**
Meter: 4in. 50μA moving coil.
Size and Weight: 7 x 5 x 3in. 2½lb.
Powered by pen cells.

VARIABLE HIGH-VOLTAGE UNIT
DIELECTRIC BREAKDOWN TESTER



★ *Range :* Infinitely variable up to 3,000 volts and can be accurately set. 0.1 amp.

★ Entirely suitable for continuous testing.

★ Built-in Automatic safety cut-out.

Input: Mains voltage.

Robustly constructed for bench use with 4½in. x 4in. modern styled meter, placed at an easy to read angle. Complete with input and test leads with clips.

Model T30, 0-3,000 v. A.C. **£32.**

Model T50, 0-5,000 v. A.C. **£40.**

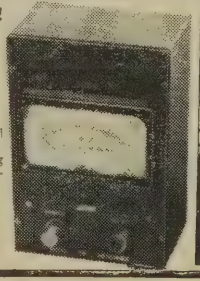
TRANSISTORIZED MEGOHMETER

NO WINDING!

PUSH BUTTON TO READ

500V.-1,000 MEGOHMS

Portable, supplied c/w batteries, probes and carrying case. Superb instrument.



ONLY £19.10.0

P. & P. 5/6.

20 AMP 24 VOLTS HEAVY DUTY SUPPLY UNIT

Made at a cost of approx. £100/0/0 by S.T. & C. LTD.

Essential equipment for Electronic Engineering, Research Laboratories, Schools. Ideal for battery charging, etc. Guaranteed for 20 amps.

Output : 24 v. D.C. variable up to 20 amps. and trickle charge.

Input : A.C. 100/260 v. 45/65 cycles. Input and output fully fused.

Size : 16 x 24 x 32in. high. In heavy gauge steel grey cabinet.

ONLY **£27.10.0** Packing & Carr. 40/-.

I·M·O (ELECTRONICS) LTD. **(Dept. WW12), 313 Edgware Road, London, W.2.** *PADdington 2233/4*

LASKY'S RADIO

London's Largest Stocks

THE HOME OF HI-F

COMPLETE MONO/STEREO SYSTEMS TO YOUR SPEC
AT LASKY'S PRIVILEGE PARCEL PRICES

DEMONSTRATION STUDIOS

Hear and compare the very latest

HI-FI EQUIPMENT

Visit our spacious showrooms at 33 Tottenham Court Road or 207 Edgware Road, whichever is most convenient. In our Demonstration Studios you can see, examine, hear and compare the very latest products in the realm of high-fidelity reproduction.

● TAPE RECORDERS ● TAPE DECKS ● MICROPHONES ● AMPLIFIERS ● CONTROL UNITS ● AM/FM TUNERS ● RECORD PLAYERS ● AUTOCHANGERS ● TRANSCRIPTION TURNTABLES ● PICK-UPS ● LOUDSPEAKERS ● SPEAKER SYSTEMS ● CABINETS AND ENCLOSURES ● TRANSISTOR RADIOS.

by all the well-known makes including:—

ARMSTRONG	G.E.C.	LORENZ	STELLA
BRENELL	GOLDRING	LOWTHER	STUZZI
CHAPMAN	GOODMANS	LUSTRAPHONE	TANDBERG
COLLARO	GRUNDIG	ORTOFON	TANNOY
CONNOISSEUR	HARTING	PAMPHONIC	TELEFUNKEN
COSSOR	H.M.V.	PHILIPS	THORENS
DULCI	JASON	QUAD	TRUVOX
E.A.R.	KORTING	RESLO	VORTEXION
ELIZABETHAN	LEAK	ROGERS	W.B.
FERROGRAPH	LENCO	SIMON	WEARITE
FI-CORD	LINEAR	SOUND	WHARFEDALE
GARRARD			

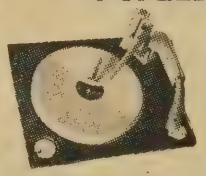
If you cannot pay us a visit please send us details of your choice of equipment and we shall be pleased to quote. See Complete Systems.

COMPLETE SYSTEMS

A Lasky's "Privilege Parcel" allows you to purchase the Audio System of your choice at a worth-while cash saving. We shall be pleased to quote our "Privilege Parcel" Prices for any selection of equipment of your own choice. Send us details of your requirements. **H.P. Terms can be arranged on Privilege Parcels.**

RECORD PLAYERS

4-SPEED AUTO-CHANGERS



SCOOP! LASKY'S CAN NOW OFFER B.S.R. AUTOCHANGERS AT LOWEST EVER PRICES!

All brand new and fully guaranteed—complete with cartridge and stylus.

UA14	£3 19 6
UA16 4-speed mains model	£4 19 6
UA14 4-speed 9 v. battery operated	£5 19 6
UA20 4-speed	£5 19 6

Add 5/- P. & P. on each.

COLLARO Studio C60 wired for stereo monaural p.u. £6 19 6

MAGNAVOX-COLLARO latest model. 4-speed Stereo Autochanger. Fitted diamond stylus and record dust cleaning attachment Stereo £7 19 6

GARRARD

Auto-Slim Mono	£6 10 0
Auto-Slim Stereo	£7 10 0
Auto-Slim Mono Plug-in head	£7 7 0
Auto-Slim De Luxe Mono AT6	£11 9 0
Auto-Slim De Luxe Stereo AT6	£12 5 0
AT5P, Mono	£10 8 2
AT5P, Stereo	£11 5 11
3000LM with stereo cartridge	£11 11 11
Postage on all above 5/-.	

TRANSCRIPTION MOTORS

GARRARD 4HF, ster or mon	£15 19 6
GARRARD 401	£32 10 0
GARRARD Lab. 80, Mono	£28 17 8
GARRARD Lab. 80, Stereo	£29 15 5
GARRARD 301 (Strobe)	£21 0 0
GARRARD A with GCS	£19 14 0
GARRARD A with EV26A	£20 10 0
PHILIPS AG/1016	£12 12 0
BRAUN PC4L Stereo	£12 9 6
CONNOISSEUR:	
Craftsman II	£17 2 11
Craftsman III	£22 19 6
Model B	£25 4 0
LENCO GL58	£17 1 9
LENCO G88	£18 18 5
LENCO GL70	£27 9 4
THORENS 135	£35 8 4
THORENS TD124	£38 7 4

SINGLE PLAYERS

Auto start and stop. With pick-up and crystal cartridge.

GARRARD T.A. Mk. II Mono £7 17 3

GARRARD SRP10 latest model single player with G.C.S. £5 9 11

E.M.I. 4-speed STEREO £3 19 6

COLLARO JUNIOR 4-speed motor and pick-up 69/6

6 volt battery version, 4-speed with pick-up 69/6

All other current models available.

Postage on all above 5/- extra.

LAST FEW ONLY—COLLARO 4TR 200 Transcription Motor and Turntable. New and unused—listed at 17 gns. **LASKY'S PRICE £9/19/6.** Carr. & P. 5/-.

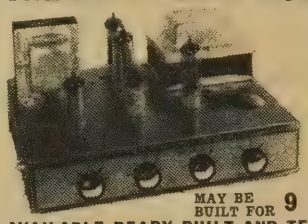
EMI 4-SPEED RECORD PLAYER

New, unused and individually boxed fitted with lightweight pick-up with ACOS G.P. 73/2 stereo cartridge. Cabinet space required 13½ × 12½ × 4½in. A 9in. metal turntable is fitted. For use on 200/250 volt A.C. Mains with Auto-stop. The stereo cartridge will play all types of Mono Records, 78s, L.P.s, etc. but if desired a G.P. 67 LP/78 Mono cartridge will be supplied in lieu of the GP73 at no difference in cost.

LASKY'S PRICE 79/6 P. & P. 3/6.

AMPLIFIERS

THE BH-14 HI-FI MONO AMPLIFIER KIT



High quality 14 watt power amplifie with separate volume controls o each input, also bass and trebl controls. Inputs: 1-5 m/v.; 2-40 m/ Output impedance 3 or 15 ohm 5 valves—line-up: 2 × EL84, 1 EF86, ECC83 and EZ81. Frequenc response 15 c/s.—20 Kc/s. Ideal fo the discerning Hi-Fi enthusiast or a guitar amp. Gold hammer finish wit distinctive Perspex front pane Complete kit of parts with detaile construction data.

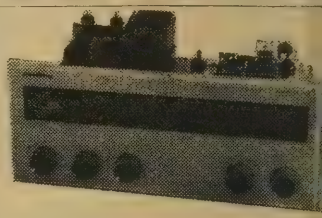
MAY BE BUILT FOR **9 GNS.** POST FREE. Insurance book available sep. 1/6.

AVAILABLE READY BUILT AND TESTED. 11 GNS. POST FRE

ARMSTRONG EQUIPMENT

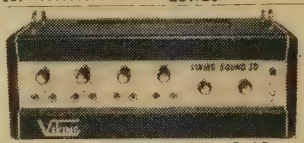
We stock all the latest models by this famous manufacturer.
Illustrated: **Model 227M—AM/FM Tuner Amplifier.**

A.F.208	£21/4/-
Model 227M	£36/15/-
Model 223	£28/15/-
Stereo 55	£29/18/-
Model 227	£52/15/-
Model 226	£61/-/-
Model 222 Amp.	£27/10/-
Model 224	£22/10/-
T.4.c.	£17/19/-
T.4.b.	£20/8/-
127M	£26/10/-
127	£37/10/-



S.T.3. Mk. II	£25 12/
A.20 Stereo Amp.	£23 12/
P.C.U. 25 Stereo Pre-amp.	£21/-/-
Optional cases	£3/10/-

H.P. Terms avilabale.



VIKING "SOUND 30"

High quality guitar and P.A. amplifier A.C. Mains operated - 30 watt output 8 inputs, fitted with 4 separate volum controls for mixing also Bass and Trebl controls. 15 ohms out. British made highest quality components use thr-ughout - fully guaranteed. In stron portable case, size approx. 20 x 9 x 6in

LASKY'S PRICE 35 GNS. Carr. & Pack. 7/6 extra.

HUGE PURCHASE OFFER

All Brand New and Unused in perfect working order.

Supplied complete with crystal microphone, reel of tape and empty spool, also screened lead for recording from radio, pick-up, etc. The following specifications are common to all three models: Tone Control, Visual Recording Indicator. Inputs: Microphone Radio, Record-Player, Radiogram, Telephone Adaptor, Fully Automatic Erase Facilities: Fast spooling, forward and reverse. Valves: Latest Mullard Miniatur types. Rectifier: S.T.C. or Westinghouse Metal Rectifier. Loudspeaker: Standar 3 ohm with extension speaker socket. Microphone: new super sensitive crystal in th new easy to hold microphone case. Carrying Case: Portable case with detachabl lid, harmonising gold trim and automatic safety locks. Storage cubby for micro phone and accessories. Covered in new type washable scratch resistant Vinyl.
Size for Models A and B: 14½ × 14 × 6½in. Size for Models C & D: 14 × 12½ × 6½in

MODEL A Studio Deck. Four Track. Speeds: 1⅞, 3¾ and 7½ i.p.s. Spoo capacity: 7in. Wow and flutter: Less than 0.15% total. Playin Times: up to 18 hours. Frequency Response: 12,000 c.p.s. at 7½ i.p.s. Mains Voltage 200-250 v. 50 c/s A.C. Output 3 watts.

LASKY'S PRICE 27 GNS. Carriage and Insurance 15/- extra

MODEL B Studio Deck, Two Track. Specification as for Four Track mode above, except that this is fitted with Two Track Studio Tape Deck Maximum Playing Time: up to 9 hours from one reel of tape.

LASKY'S PRICE 25 GNS. Carriage and Insurance 15/- extra

MODEL C Fitted with B.S.R. Deck, two-track version. Specification: Singl speed, 3¾ i.p.s. Freq. response 10,000 c.p.s. at 3¾ i.p.s. Spoo capacity: 5½in. Mains voltage: 200-250 v. 50/60 c/s. A.C. Wow and flutter: Less tha 0.2% total. Output: 3 watts. Playing time: up to 3 hours.

LASKY'S PRICE 18 GNS. Carriage and Insurance 15/- extra

MODEL D Fitted with B.S.R. Four Track Deck—otherwise same specificatio as the Model C—but maximum playing time increased up to 6 ho

LASKY'S PRICE 21 GNS. Carriage & Insurance 15/- extra

H.P. Terms are available on the above models.

TAPE DECK MOTORS Motors for the Collar Studio Deck—new an unused. 200-250 v. A.C. Take-up and rewind. **Listed at £2/5/- each**

LASKY'S PRICE 14/11 each P. & P. 2/6.

State motor required when ordering.

High quality tape deck capstan motor made by E.M.I. Holland. Bi-directional. Six 4in. dia. × 2in. high, 1in. × ¼in. spindle. **LASKY'S PRICE 19/11** P. & P 3/6.

LASKY'S FOR ALL TEST GEAR & TECHNICAL ADVICE

14WW—132 FOR FURTHER DETAILS.

Audio Equipment & Components

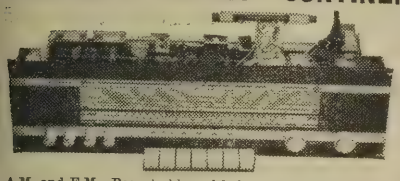
& TAPE RECORDERS

THE FINEST RANGE OF MONO/STEREO MAINS AND TRANSISTORISED PORTABLES

LASKY'S RADIO

CONSTRUCTORS BARGAINS

THE NEW "KUBA" CONTINENTAL AM/FM STEREO RADIOGRAM CHASSIS



Long, medium and short waveband coverage, plus V.H.F./F.M. Piano key wavechange. Separate flywheel tuning on A.M. and F.M. Bass, treble and balance controls. Magic-eye tuning indicator. Ferrite rod aerial. The very latest printed circuitry. Provision for multiflex. 5 valves: line-up: ECC85, ECH81, ECC83, ELL80, EAF801. Full vision tuning scale size 21 × 6in. Overall dimensions 21 × 6½ × 8in. Made to the very highest standards.

LASKY'S PRICE 29½ GNS. Carriage and insurance 12/6 extra.

JASON KITS

High quality construction kits for the discerning Hi-Fi enthusiast. We stock the complete range.

TUNER KITS

FMT1. Can be built for **£6/15/-**. P. & P. 2/6.

FMT2 .... **£10 12 0.** P. & P. 4/-.
FMT3. .... **£12 5 0.** P. & P. 4/-.
Mercury II **£10 12 6.** P. & P. 2/6.
JTV2 .... **£15 10 0.** P. & P. 4/-.
JTL Stereo tape link-comp. kit **£22/1/-**. P. & P. 4/-.

TEST EQUIPMENT KITS
Can be built for:

AG 10 Audio Gen., £15/19/-. P. & P. 4/-.
OG 10 Scope, exc. tube, **£17/19/6.** P. & P. 4/-.
W 11 Wobbulator, £14/19/-. P.P. 4/-.
EM 10 Valve voltmeter, £23. P.P. 4/-.

BUILD A HIGH QUALITY TAPE RECORDER

Using the famous Collaro "STUDIO" deck and MARTIN pre-assembled amplifiers 2- or 4-track models.

COLLARO STUDIO TAPE DECK.
Latest model 3 speed, 3 motors. Take 7in. reels. Fitted with half-track heads. **LASKY'S PRICE £10/10/-.** New and Unused. Carr. & Pack. 7/6.

COLLARO STUDIO TAPE DECK. As above but fitted with the latest quarter-track heads. **LASKY'S PRICE £13/19/6.** Carr. & Pack. 7/6.

MARTIN TAPE RECORDER AMPS. Designed for use with Collaro Studio Tape Deck. In sub-assemblies for immediate installation. 6-valve circuit. Comprehensive instructions make final assembly as simple as possible. Everything supplied including valves, etc. Monitoring facilities. 3-ohm output, speed equalising, etc. For 200-250 v. A.C. mains.

PRICES ¼-track Model **£11/11/-.** ½-track Model **£12/12/-.** P. & P. 2/6. Portable carrying case designed to take the Collaro Studio Tape Deck and the Martin Tape Amplifier. Fitted with 9 × 5in. speaker. Price complete with speaker **£5/5/-.** P. & P. 5/-.

HI-FI FURNITURE

by RECORD HOUSING

The full range of Record Housing equipment cabinets, speaker enclosures, etc., stocked. Delivered anywhere. Catalogue FREE on request.

FROM PRE-AMP TO 20 WATT HI-FI STEREO ASSEMBLY BY BUILDING WITH MARTIN AUDIOKITS—AVAILABLE FROM STOCK.

Using specially developed circuits, the very latest transistors and printed circuits—these kits are all fully checked and tested before leaving the factory. Although the kits are basically designed for use together the pre-amplifier and mixer stages may be used to great advantage with existing valve or transistor equipment.

KIT 1.	5-stage Matching Input Selector Unit	LASKY'S PRICE 47/6.
KIT 2.	Pre-amplifier with volume control	LASKY'S PRICE 37/6.
KIT 3.	3-Channel Mixer with plug-in adaptors for individually matching each circuit. Adaptors 8/6 each	LASKY'S PRICE 79/6.
KIT 4.	Pre-amplifier with tone/volume control stages	LASKY'S PRICE 62/6.
KIT 5.	10 and 3 watt Main Amplifier	LASKY'S PRICE £5/12/6.
KIT 6.	Power supply converter unit	LASKY'S PRICE 52/6.
KIT 7.	15 ohm version of Kit 5	LASKY'S PRICE £6/12/6.
KIT 8.	Power supply for Kit 7	LASKY'S PRICE £2/15/-.

THE PETIT FULMITER Designed to replace PP3 9 v. battery. Operates direct from 200-250 A.C. Same size as PP3. **18/6** P. & P. 1/6

SEND FOR OUR LATEST BARGAIN BULLETIN. 20 foolscap pages. Hundreds of Bargains for the "ham" and service man. PRICE 6d. POST FREE.

MICROPHONES

LAFAYETTE PA-400

UNI-DIRECTIONAL DYNAMIC MICROPHONE

Superbly made and finished. Dual impedance 600Ω : 50KΩ. Frequency range 50-1,500 c/s. Diecast body with adjustable elbow, satin chrome and matt black finish. Complete with lead.

LASKY'S PRICE 11 GNS. P. & P. 2/6.

AIWA DM-51 *SPECIAL HUGE PURCHASE PRICE*

DYNAMIC STICK MICROPHONE WITH BASE

Available with 50 KΩ, 600Ω, or 35Ω impedance. Frequency 50-1,500 c/s. Sensitivity: 75 dB (600Ω and 35Ω)—55 dB (50 KΩ). Non directional. Beautifully finished in satin chrome and matt black. Complete with removable table stand and lead.

LASKY'S PRICE £6/19/6 P. & P. 2/6

BM-3. High impedance crystal stick microphone, with removable base and muting switch. Finished in black enamel and chrome. Complete with lead, neck harness and stand adaptor. **LASKY'S PRICE 39/6.** P. & P. 2/6. Heavy matching table base, **12/6.** P. & P. 2/6.

DM-304 Dual impedance dynamic with on/off switch. Satin chrome finish. Complete with lead. **LASKY'S PRICE 89/6.** P. & P. 2/6.

ACOS CRYSTAL STICK MIC. Type MIC. 39/1, complete with cable. List £5/5/-. **LASKY'S PRICE 32/6.** Post free.

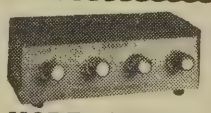
DX-29. High imp. Dynamic mic. Die cast metal pencil body. Complete with stand and lead. **LASKY'S PRICE 59/6.** P. & P. 2/6.

DX-62. High impedance dynamic with on/off switch. Chrome/enamel finish. Complete with lead. **LASKY'S PRICE 89/6.** P. & P. 2/6.

DF-1. Miniature dynamic stick. Size only 3¾in. long × ¾in. Two-tone enamel finish. Complete with lead and clip on stand. **LASKY'S PRICE 52/6.** P. & P. 2/6.

DM-13. High impedance dynamic. Directonal. With on/off switch. Satin chrome finish. Complete with lead. **LASKY'S PRICE £5/5/-.** P. & P. 2/6.

FILM INDUSTRIES TYPE M3 RIBBON MICROPHONE. New and unused. Low imp. Complete with 12ft. twin screen cable and 4in. stay-put flexible tube. Listed at £8/15/-. **LASKY'S PRICE £6/19/6** P. & P. 2/6. Heavy metal table base for above 10/- extra.



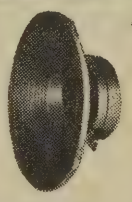
THE HARROW TRANSISTORISED MICROPHONE MIXER

Will mix 4 high impedance channels: mikes, tape, rec's., tuners, grams., etc. 9 v. battery operated. Neatly styled, size only 6in. × 2¼in. × 2¼in. Standard jack sockets. Complete with PP3 battery, full circuit dia., and operating instructions.

MODEL TM4 Mono, **59/6** P. & P. 2/6. **MODEL** SM5 Stereo, **72/6** P. & P. 2/6.

SPEAKERS

SPECIAL OFFER 12" FANE DUAL CONE HI-FI SPEAKER

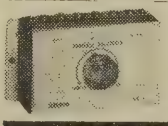


Type 122/17A. Power handling 25 watts—15 ohms imp. Flux density 17,000 gauss. Special Anisotropic magnet. Listed at 12 gns. Limited stock.

LASKY'S PRICE £6/19/6 P. & P. 5/-.

TYPE 8CX1 8" HI-FI SPEAKER (IMPORTED)
Power handling 10 watts, 15Ω imp. **LASKY'S PRICE 6GNS.** P. & P. 5/-.

THE NEW STUDIO RANGE OF CELESTION HI-FI SPEAKERS NOW IN STOCK.



VARIABLE CROSSOVER

THE HARROW CV 1. Gives variable volume control of Woofer and Tweeter. Strong metal construction. Size 4in. × 2⅝in. × 1½in. Screw tag connections.

LASKY'S PRICE 22/6 P. & P. 1/6.

SPECIAL INTEREST ITEMS!

DEAC RECHARGEABLE NICKEL CADMIUM CELLS

Rating 1.22 v. 3.5 A.H. at 10 hour rate. 1,001 uses for model makers, miniature equipment, portable radios, transistor radios, T.V.s and tape recs., trans receivers, photo flash, etc. Hermetically sealed. Size 3½ × 1⅜ × 1⅜in. Listed at 35/- each.
LASKY'S PRICE 15/- each. POST FREE. BANK of 9, **79/6.**

THE HARROW POWER PACK

Battery eliminator for portable radios, etc. Converts your battery radio to A.C. mains. Replaces 4½ v., 6 v. and 9 v. batts. Size only 3in. × 2in. × 2½in. State Voltage required when ordering.

LASKY'S PRICE 29/6 P. & P.

LASKY'S FOR D.I.Y. CONSTRUCTION BARGAINS P.T.O. FOR MORE NEWS

14WW—133 FOR FURTHER DETAILS.

LASKY'S RADIO

For The Finest Value an

TRANSISTOR RECEIVERS

THE WIDEST RANGE AVAILABLE TODAY FOR HOME CON STRUCTION OR READY BUILT TO HIGHEST STANDARD

We consider our Construction Parcels to be the finest value available on the home construction market. If on receipt you feel not competent to build the set, you may return it as received within 7 days, when the sum paid will be refunded less postage.

TRANSISTOR PORTABLES

THE SKYROVER AND SKYROVER DE LUXE

★ **LONG WAVEBAND COVERAGE IS NOW AVAILABLE FOR THE SKYROVER and SKYROVER DE LUXE.** A simple additional circuit provides coverage of the 1100/1950 M. band (including 1500 M. Light programme). This is in addition to all existing Medium and Short wavebands. All necessary components with construction data. **Only 10/- extra Post Free.** **This conversion is suitable for Skyrover and Skyrover De Luxe receivers that have already been constructed.**

GENERAL SPECIFICATION
7 transistor plus 2 diode superhet, 6 waveband portable receiver.
The SKYROVER and SKYROVER DE LUXE cover the full Medium Waveband and Short Waveband 31-94M, and also 4 separate switched band-spread ranges, 13M, 16M, 19M and 25M, with Band Spread Tuning for accurate Station Selection. The coil pack and tuning heart is completely factory assembled, wired and tested. The remaining assembly can be completed in under three hours from our easy to follow, stage by stage instructions.
SPECIFICATION: Superhet, 470 Kc/s. All Mullard Transistors and Diode. Uses 4-U2 batteries. 5in. Ceramic Magnet P.M. Speaker. Easy to read Dial Scale. Band Spread Tuning. 500 MW Output. Telescopic Aerial and Ferrite Rod Aerial.
WAVEBAND COVERAGE: 180-576M; 31-94M and Band Spread on 13, 16, 19 and 25 metre Bands.

The SKYROVER

Controls: Waveband Selector, Volume Control with on/off Switch, Tuning Control. In plastic cabinet, size 10 × 6½ × 3¾in. with metal trim and carrying handle.

Can now be built for **£8.19.6** P. & P. 5/- extra.
H.P. Terms: £1 deposit and 11 monthly payments of 16/6.

The SKYROVER De Luxe

Tone Circuit is incorporated, with separate Tone Control in addition to Volume Control. Tuning Control and Waveband Selector. In a wood cabinet, size 11½ × 6¾ × 3in. covered with a washable material, with plastic trim and carrying handle. Also car aerial socket fitted.

Can now be built for **£10.19.6** P. & P.. 5/- extra. **H.P. Terms: 25/-deposit and 11 monthly payments of 20/-.**

Data for each receiver: 2/6 extra. Refunded if you purchase the parcel. Four U2 batteries 3/4 extra. All components available separately.

REALISTIC SEVEN

Fully tunable long and medium bands. Uses 7 Mullard Transistors; plus Diode OA70.
STAR features:
● 7 Transistor Superhet. ● 350 Milliwatt output 4in. high flux speaker. ● All components mounted on a single printed circuit board, size 5½in. × 5½in. in one complete assembly. ● Plastic cabinet, with carrying handle, size 7in. × 10in. × 3¾in., in blue/grey. ● Easy to read dial. ● External socket for car aerial. ● I.L. frequency 470 Kc/s. ● Ferrite rod internal aerial. ● Operates from PP9 or similar batt. ● Full comprehensive data supplied with each Receiver. ● All coils and I.F.s etc., fully wound ready for immediate assembly. An outstanding Receiver.

Can be built for
£5 . 19 . 6
P. & P. 4/6.

REALISTIC SEVEN De Luxe

By popular request a De Luxe version of the well-known Realistic Seven now available. With the same electrical specification as standard model—PLUS A SUPERIOR WOOD CABINET IN CONTEMPORARY STYLING covered in attractive washable material, with super-chrome trim and carrying handle. Also a full vision circular dial, externally mounted to further enhance the pleasant styling. **ONLY £1 EXTRA**
Both models: Battery 3/9 extra. (All components available separately.) Data and instructions separately 2/6, refunded if you purchase parcel.

SINCLAIR SUPER MINIATURES

THE SINCLAIR MICRO-6 Self-contained pocket radio. **size only 1⅝" × 1 11/16" × ⅝".** A marvel of modern miniatu isation—truly amazing performance. Without a doubt the most advanced transistor circuit ever offered to home constructors—yet may be built in an evening. Complete with earphone and detailed construction data. **59/6**
Mercury cell **1/11** extra (2 required). All parts sold sep. **CAN BE BUILT FOR**

THE SINCLAIR SLIMLINE The new 2-transistor pocket radio size only 2⅝in. × 1⅝in. × 1⅛in. Micro alloy transistorised and printed circuit. Easy to assemble. **49/6**
All components available separately. **CAN BE BUILT FOR**

THE NEW SINCLAIR X10 10 watt power amplifier fitted with integrated pre-amplifier. Requires only 1 mV. for an output of 10 watts undistorted. Frequency response is flat ± dB from 5 c/s. to 20 kc/s. Size only 6 × 3 × ⅞in. Weight 5 ozs. Built on printed circuit. Operates from 12 v. D.C. at 75 mA. quiescent. Circuit uses 7 M.A.T.s and 4 RF power transistors.
KIT PRICE £5.19.6 POST FREE.
AVAILABLE READY BUILT, TESTED AND G'TEED, £6/19/6 POST FREE.
3 pots. for vol., Bass and Treble, 7/6 the 3 extra. Mains power pack, if required, 54/-.

MINIATURE EARPIECES for Transistor Radios, Transparent

ear inserts with 3ft. cord, sub-min. jack and socket. Fully guaranteed. Post free.
CR.5 Crystal high imp. 5 0
MR.4. Magnetic low imp. 6 6

READY BUILT BARGAINS

THE "TRANSISTOGRAM"

A portable battery operated fully transistorised Record Player—Made by famous British manufacturer, fully guaranteed. Size 6½ × 12 × 10½in. Weight 10 lbs. Operates on 6 U2 batts. 4 speeds—16⅔, 33⅓, 45 and 78 r.p.m. Goldring Cygnet player unit with lightweight pick-up fitted with CM-60 turn over ceramic cartridge. Output 500 mW into 5in. ceramic magnet speaker fitted into lid for maximum sound distribution. Cabinet constructed of wood, covered in two tone (pale blue/grey) leather cloth. High quality amplifier with tone and vol. controls gives excellent reproduction. Plays 7in., 10in. and 12in. records. Today's value 12 gns.
LASKY'S PRICE £6.19.6 New, boxed and guaranteed. Exc. batt Carr. & Ins. 7/6.

BOY'S 2 TRANSISTOR POCKET RADIO

In attractive plastic case. Size only 4in. × 2½in. × 1in. Fitted with 2½in. loudspeak Socket for personal earpiece. Uses PP3 battery. Tunable over full medium waveban Complete with earpiece, carrying purse and 9-volt battery. Ideal Birthday present. **LASKY'S PRICE 42/-** P Fr

THE AJAX—SUPER DE LUXE TRANSISTOR RADIO

6 Transistor—2 waveband model fully tunable over full Long and Medium waveband Fitted telescopic aerial and socket for personal earphone—real leather case. Plast case in cream and black. Size 6in. × 3½in. × 1½in. Uses PP3 battery. Complete wi leather case, battery and personal earphone. New and guaranteed. **LASKY'S PRICE £5.19.6** Post free.

6 TRANSISTOR POCKET RADIO

Fully built-in, plastic case, 4in. × 2½in. × 1in. with 2½in. speaker. Uses single P type battery. Supplied complete with personal earpiece and leather case. Tunab over full medium waveband. Complete with all accessories. **LASKY'S PRICE 69/6** Post free.

BABY ALARM/INTERCOM

Fully transistorised miniature intercom that has all the features of sets many times its size. Battery consumption is exceptionally low and makes this system particularly suitable for use as a Baby Alarm. Specification: 2 transistor; Sensitivity; more than 55 dB. Power: one 9 v. PP9 or equiv. (approx. life 50 hours). Size of units 4 × 2½ × 1¼in. The sturdy plastic cabinets are finished in ivory and silver with chrome stands. **LASKY'S PRICE 59/6** P. & P. 2/6

TRANSISTORISED TAPE RECORDERS

A few only still available. High quality models. Prices from 13 Gns. to 20 Gns. See our advertisement "W.W." Sept., 1964, for details.

CONSTRUCTORS BARGAINS

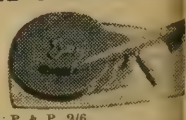
TRANSISTORS ALL BRAND NEW AND GUARANTEED

GET 81, GET 85, GET S6 2/6; 837A, 874P 3/6; OC45, OC71, OC81D 4/6; OC OC 70, OC 76, OC 81 (match pair 10/6) 5/6; AF 117, OC 75, OC 170 OC 200 6/ OC 23 OC 42, OC 43, OC 73, OC 82D 7/6; OC 201, OC 204 15/-; OC 205, OC 206 19/ OC 28 24/6.

TRANSFILTERS By BRUSH CRYSTAL CO. Available from stock.

TO—O1B 465 kc/s. ± 2 kc/s. | TO—O2D 470 kc/s. ± 1 kc/s.
TO—O1D 470 kc/s. ± 2 kc/s. | TF—O1B 465 kc/s. ± 2 kc/s.
TO—O2B 465 kc/s. ± 1 kc/s. | TF—O1D 470 kc/s. ± 2 kc/s.
6/6 EAC P. & P. 6

STAAR KINDER RECORD PLAYER



45 r.p.m. 6 v. Batt. operated. Complete with pick-up fitted crystal cartridge. Size only 7½ × 6in. Fitted auto. stop and start. New and perfect. Suitable for use with both the below listed amplifiers.
LASKY'S PRICE 49/6 P. & P. 2/6.
NOW IN STOCK—2 speed model for 33⅓ and 45 r.p.m. (As illustrated) **69/6** P. & P 2/6.

NPN-PNP Transformerless Transistor Amplifier. Smallest ever, size 1in. × 1in. × 1 Output 125 MW from 9 v. batt. Uses 3 transistors. Single-ended push-pull outp Fully assembled. **LASKY'S PRICE 29/6** Post 2/6.
400 MW Output version of above amp., 52/6. Post 2/6.

HI-FI TAPE RECORDER HEADS

High Imp. Reco Play. Low imp. era
Upper or lower track. **LASKY'S PRICE 29/6.** Post free per pair. State wh required.
MARRIOTT "X" Type ¼-track heads. **LASKY'S PRICE 4 GNS. pair.**
¼-track heads Record/Play and Erase. **LASKY'S PRICE 59/6 pair.**
MICHIGAN ¼-track heads. .....**LASKY'S PRICE 5 GNS. pair.**
BOGEN ¼-track heads. .....**LASKY'S PRICE 7 GNS. pair.**

PANEL METER

Full scale deflection 1 mA. Scaled 1 to 10 and "Record Level." Flush mounting—plastic construction. Easy to read. Size: 2½in. sq. × 1¼in. deep. **LASKY'S PRICE 19/6.** P. & P. 1/6.

P.T.O. FOR MORE NEWS

LASKY'S FOR SPEEDY MAIL ORDER SERVICE

14WW—134 FOR FURTHER DETAILS.

Service in Great Britain

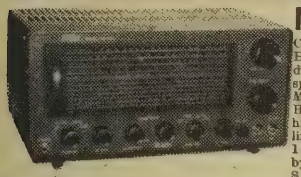
CONSTRUCTORS BARGAINS

HUGE STOCKS OF COMPONENTS, TEST GEAR, ETC.
SPEEDY MAIL ORDER SERVICE

LASKY'S RADIO

COMMUNICATION RECEIVERS

Now avail. in KIT form. Brand New—Boxed and Guaranteed.



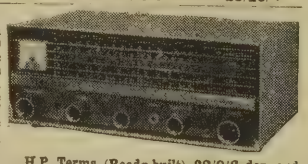
MODEL HE30 KIT

Covers range from 540 Kc/s. to 30 Mc/s. Ham Band is provided with a scale for direct reading, and can also be band spread. Facilities: A.N.L., A.V.C. and M.V.C. Q Multiplier also serves as B.F.O. H.F. stage and two I.F. stages ensure high sensitivity and selectivity. Valve line up: 3×6BA6, 2×6BE6, 2×6AV6, 1×6Q8 and 5Y3. 2 Aerial Sockets. Stand-by position for use with a transmitter, S meter fitted. 200-250 v. A.C. mains. Brand new and unused. Boxed with full instruction manual, in attractive steel cabinet, grey crackle finish. Cabinet size 15×8×10in. Dial 12×4in. Complete with full construction data.

LASKY'S KIT PRICE 32 GNS. Carriage & Packing FREE
ALSO AVAILABLE READY BUILT AND TESTED, 40 GNS. P. & P. FREE.
H.P. Terms (Ready Built): £4/4/- deposit and 11 monthly payments of £3/16/-.

MODEL HE40

Covers medium wave band and 1.6-4.4 Mc/s., 4.5-11.0 Mc/s., 11.0-30.0 Mc/s. in separate switched band spread ranges. Controls include B.F.O. Sensitivity, A.N.L., Receiver—Stand-by Switch, Tone Switch, S-Meter. For 200/250 v. A.C./D.C. Internal loop and telescopic antennae fitted. Valve line-up: 12BE6, 12BA6, 12AV6, 50C5, and metal rectifier. Size 13½×8½×5¾in. Instruction manual included.



H.P. Terms (Ready built) £2/9/6 dep. and 11 months at £2/5/-.

LASKY'S KIT PRICE 17 GNS. C. & P. FREE. Avail. ready built & tested £24.15.0 P. & P. FREE

MODEL HE80

14-valve super sensitive communication receiver. Freq. range 540 Kc/s.—30 Mc/s. and 144-146 Mc/s. Dual conversion on 2 metres, with extra R.F. stage. Single R.F. stage, two I.F. stages on all other bands. B.F.O. and Q-multiplier circuits. Improved A.N.L. and voltage regulated powerpack. "S" meter, band spread on amateur bands, large illuminated dial with logging scale. All controls fitted. Outputs for speaker and 'phones. Valve line-up: 4×6AQ8, 3×6BA6, 2×6BE6, 1×6BL8, 6AL5, 6AQ5, 6CA4 and OA2. Steel case 17×7½×10in. For 200/250 v. A.C. mains. Brand new and boxed with full instruction manual.

H.P. TERMS available.

LASKY'S KIT PRICE 47 GNS. Carriage & Packing FREE. Available ready built & tested 59 GNS. P. & P. FREE
H.P. terms are available for kits.

TEST EQUIPMENT

The "Sixteen" Multirange

METER KIT

This outstanding meter was featured by *Practical Wireless* in the Jan. '64 issue. Lasky's are now able to offer the complete kit of parts as specified by the designer.
RANGE SPECIFICATION
D.C. volts: 0-2.5-25-50-250-500 at 20,000Ω/V.
A.C. volts: 0-25-50-250-500 at 1,000Ω/V.
D.C. current: 0-50μA, 0-2.5-50-250 mA.
Resistance: 0-2000Ω, 0-200kΩ, 0-20 MΩ.
Basic movement: 40μA f.s.d. moving coil. With universal shunt full scale deflection current is 50μA.
Size/finish: Black plastic case—3½×5½×1¾in.
Controls: 15 position range switch: separate slide switch for A.C. volts—D.C. ohms; ohms zero adjustment pot. meter; meter zero. External connections: Two 4 mm. sockets for test lead plugs.
Power requirements: One 1.5v. and one 1.5v. batts. Complete with all parts and full construction details.

LASKY'S PRICE £5.19.6 P. & P. 5/-.

H.P. Terms: 21/- deposit and 5 monthly payments of 21/-.
Data and circuit available separately, 2/6; refunded if all parts bought. Pair of batteries 2/5 extra.

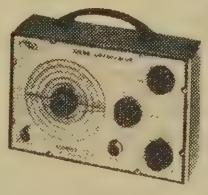
READY BUILT TEST METERS

All brand new—complete with test leads and batts.

HAIKI 20,000 O.P.V. LASKY'S PRICE	£5	19	6
TE-13 1,000 O.P.V. LASKY'S PRICE	£1	19	6
TMK-500 30,000 O.P.V. LASKY'S PRICE	£8	17	6
200-H 20,000 O.P.V. LASKY'S PRICE	£5	5	0
P-1 2,000 O.P.V. LASKY'S PRICE	£2	12	6
P-3 4,000 O.P.V. LASKY'S PRICE	£4	2	6
MT-855 30,000 O.P.V. LASKY'S PRICE	£10	19	6

Also complete range of Avo and Taylor Meters and Test Equipment in stock.

NOMBREX TEST EQUIPMENT



MODEL 27 TRANSISTORISED SIGNAL GENERATOR (illustrated)
Wide range—150 kc/s. to 350 Mc/s. Accuracy better than 2%. Direct calibration. AF, RF and MOD. Battery operated. Light weight and strongly made. Complete with test leads and batt.
LASKY'S PRICE **£9.12.3** Post Free.

OTHER NOMBREX MODELS AVAILABLE ALL TRANSISTORISED.

MODEL 63. Wide range AUDIO GENERATOR. 10-100 Kc/s. **£16/15/0.**
MODEL 66. Wide range INDUCTANCE BRIDGE. 1μH to 100H in 4 ranges. Measures Q. **£18/0/0.**
POWER SUPPLY UNIT
1 to 15 v. D.C up to 0.1 amp. 230/250v. A.C. mains. **£6.10.0** P. & P. 2/6

LAFAYETTE TAPE

Famous American Brand—Fully Guaranteed at record low prices. In sealed cartons.

5in.	Double play, 1,200ft. Mylar base	15/-
5in.	Long play, 900ft. Acetate base	10/-
5in.	Standard play, 600ft. P.V.C. base	8/6
5½in.	Long play, 1,200ft. Mylar base	15/-
5½in.	Double play, 1,800ft. Mylar base	22/6
5½in.	Long play, 1,200ft. Acetate base	12/6
5½in.	Standard play, 850ft. P.V.C. base	11/6
7in.	Standard play, 1,200ft. Mylar base	12/6
7in.	Long play, 1,800ft. Mylar base	19/6
7in.	Double play, 2,400ft. Mylar base	25/-
7in.	Long play, 1,800ft. Acetate base	15/-
3in.	Message tape, 150ft.	3/6
3in.	Message tape, 225ft.	4/11
3in.	Message tape, 300ft.	7/6
3in.	Triple play, 450ft. Mylar base	12/6
4in.	Triple play, 900ft. Mylar base	22/6
5in.	Triple play, 1,800ft. Mylar base	42/6
5½in.	Triple play, 2,400ft. Mylar base	55/-
7in.	Triple play, 3,600ft. Mylar base	75/-

P. & P. 1/- extra per reel; 4 reels and over Post Free

RECORDING TAPE SPLICER

By famous manufacturer, all metal nickel plated construction. With separate razor blade, securely clamps tape while splicing. Listed at 18/6.
LASKY'S PRICE **14/6** Post Free.

GUITAR PICK-UPS

CGM5 Crystal—high imp. Size only 1¼in.×½in.×½in. Clips to finger board—no screws. Complete with cable.
LASKY'S PRICE **15/11** P. & P. 1/-.

CGM35. Magnetic—high imp. Fully adjustable pick-up position carrier. Simply fixed. Separate tone and volume control. Heavy chrome finish. Pick-up size 3¼in.×1¼in., control size 2¼in.×1¾in., complete with long lead and screened jack plug.
LASKY'S PRICE **59/6** P. & P. 1/6.

EXPORT MODEL—SUPER TV OFFER
625 line T.V. chassis (Export Model). For 200-250 v. A.C./D.C. mains. Fitted with Band I-III turret tuner. Fully loaded with 12 sets of coils for all CC1R channels in these bands. F/M sound. Made by famous British manufacturer. 15 Mullard valves. Electrostatic focus and deflection. Will take 17in., 19in., 21in. or 23in. CRT. All controls fitted. Supplied new and unused with all valves, 7in.×4in. speaker and 17in. CRT (less cabinet).
LASKY'S PRICE **£25** Carr. & packing FREE to any part of the World.
(Tube sent at buyer's risk). An allowance of £1 will be made if the CRT is not required. Circuit data included FREE.

CRYSTAL PICK-UP CARTRIDGES

LOWEST PRICES EVER!

All Complete with Styli L.P. and Standard (and Stereo where shown), fully guaranteed. Standard Fitting will fit most P.U. Arms and Heads. Postage 1/- extra each.

Garrard Magnetic T.O.M.2	15/-
Acos GP.59	14/-
Acos G.P.65/3	15/-
Acos GP.65/1	17/-
Acos G.P.67/1	14/-
STEREO Acostereo 73/1, with 2 sapphires	25/-
Acostereo 73/2, with diamond LP/Stereo and sapphire Std.	29/6
Ronette Stereo O.V. Turnover, with 2 sapphires	25/-
Ronette Stereo type 105 and 106 with 2 sapphires	25/-
Ronette Stereo type 105 and 106 with diamond LP Stereo and sapphire Std.	35/-

AND EVEN LOWER PRICES

Save money! Some of these cartridges are cheaper than styli.

C.T.I Mono 2 sapphires	4/11
Collaro Type C, 2 sapphires, stereo	15/-
Collel SCI Diamond LP, stereo	17/6
Sonotone 8T, stereo	19/11
Sonotone 2TA, mono.	15/-

Postage 1/- extra each.

TAPE POSITION INDICATOR

Open type—as used by most makers. With re-set knob.
3 DIGIT 7/6. 4 DIGIT 10/6. P. & P. 9d. on each.

33 TOTTENHAM COURT ROAD, W.1. 2 mins. Oxford Street. Nearest Station, Goodge Street. MUSeum 2605
Open all day Saturday. Close 1 p.m. Thursday.

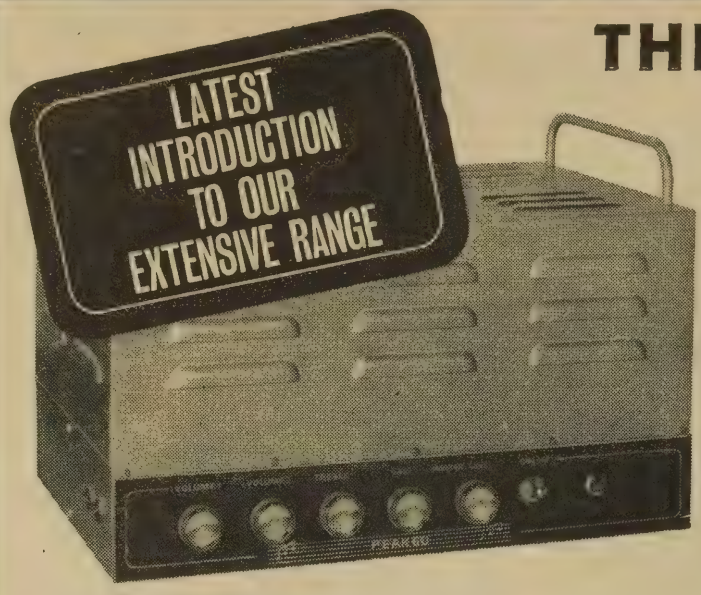
207 EDGWARE ROAD, W.2. Few yards from Praed Street. PADdington 3271/2
Open all day Saturday. Close 1 p.m. Thursday.

ELECTRONICS (FLEET ST.) LTD. **152/3 FLEET STREET, E.C.4.** Near "Daily Express" Building. FLEet St. 2833
Open all day Thursday. Close 1 p.m. Saturday.

PLEASE ADDRESS ALL MAIL ORDERS TO OUR HEAD OFFICE:—207 EDGWARE ROAD, W.2.

LASKY'S RADIO FOR FINEST VALUE and COURTEOUS SERVICE

14WW—135 FOR FURTHER DETAILS.



THE PEAK 60

60 WATT GUITAR AMPLIFIER

A multi-purpose high output power amplifier for MICROPHONE and INSTRUMENTAL applications or for providing high quality sound for Auditoriums—Halls—Dance Bands and Outside Public Address functions.
As the amplifier is capable of delivering 60 watts over a wide frequency range it is equally suitable for Bass Guitar, Lead Guitar, or Voice Reproduction. In addition it will meet the most discriminating requirements in domestic sound installations where peak power is not of prime importance.
The use of the two inputs with their associated volume controls, together with the Master volume control gives an effective mixing facility. Silver hammer finish. Black perspex front panel. Overall size 14in. × 9in. × 7⅝in. high including cover (plus 1½in. high handles).

- **BASS & TREBLE CONTROLS**
- **MASTER VOLUME CONTROL**
- **MIXING FACILITIES**
- **BUILT-IN PRE-AMPLIFIER AND CONTROL UNIT**
- **60 WATT UNDISTORTED OUTPUT**
- **SWITCHED OUTPUT for 3 or 15 ohms loudspeakers**
- **TWO INPUTS High gain and low gain with individual volume controls**

FULL DETAILS ON REQUEST

COMPLETE KIT OF PARTS £18/18/- C. & I. 5/-
ASSEMBLED & TESTED £25/4/- C. & I. 5/-
(Ventilated Cover with chrome plated handles as illustrated 35/- extra)

STERN-

GREAT BRITAIN'S GREATEST

STERN CLYNE

SOUND REPRODUCING AND HI-FI

EQUIPMENT

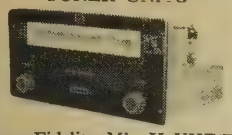
READY BUILT AND TESTED OR KITS OF PARTS FOR HOMECONSTRUCTION

MAKE YOUR CHOICE FROM THE FOLLOWING:

	Complete Kit of parts	Ready built and tested	Carr. and Ins.	Instruction book available separately
Stern Mono-Gram Amplifier, 3 watts	£4 10 0	£6 0 0	3/6	2/6
Mullard 2-valve Audio Pre-amplifier	£6 6 0	£9 10 0	5/-	2/-
Mullard 3-valve Audio Pre-amplifier	£10 0 0	£13 13 0	5/-	3/6
Stern JL10 Double Feature Pre-amplifier for Audio and Tape	£13 13 0	£19 19 0	5/-	5/-
Mullard "3-3" Amplifier with Passive Control Unit Model 33/RC. 3 watts	£8 8 0	£11 10 0	6/6	2/-
Mullard "5-10" Main Amplifier, Model 510/M. 10 watts	£10 0 0	£13 10 0	6/6	2/-
Mullard "5-10" Amplifier with Passive Control Unit. 10 watts	£12 0 0	£16 0 0	7/6	2/-
Stern JL10 Main Amplifier Mono. 10 watts	£10 0 0	£13 13 0	8/6	3/-
Stern Twin Three Stereo Amplifier. 3 watts per channel	—	£9 0 0	5/-	—
Stern Twin Three Stereo Amplifier in Portable Case with Two Speakers and Leads	—	£16 10 0	10/-	—
Mullard "10 + 10" Stereo Amplifier. 10 watts per channel	£16 0 0	£20 0 0	8/6	3/-
Mullard "10 + 10" Stereo Amplifier with Passive Control Unit. 10 watts per channel	£20 0 0	£24 0 0	10/-	3/-
Mullard 4-channel Electronic Mixer Unit Model 2H for 2 Mics, Radio and Gram	£8 8 0	—	5/-	2/6
Mullard 4-channel Electronic Mixer Unit Model 1L	£10 5 0	—	5/-	2/6
HF/TR3 Tape Amplifier with Power Unit	£13 13 0	£19 0 0	7/6	3/-
Type 'C' Tape Pre-amplifier with Power Unit	£14 0 0	£19 10 0	7/6	3/6
STP-1 Tape Pre-amplifier with Power Unit. Mono and Stereo	£22 0 0	£28 0 0	8/6	5/-
CR3/S Tape Recorder with Studio Deck	£33 8 0	—	15/-	3/-

INDIVIDUAL DESCRIPTIVE LEAFLETS GIVING TECHNICAL SPECIFICATIONS, DIMENSIONS, PRICES, TERMS, ETC., FREE ON REQUEST.

TUNER UNITS



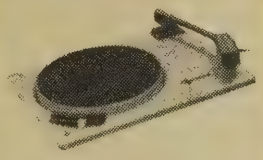
Stern Fidelity Mk. II VHF/FM Tuner (illus.). Including Mullard Tuning Heart it has been specially designed to operate with Stern Mullard Amplifiers.
Kit of parts £10 10 0
Built and tested £14 5 0
Carr. & Ins. 5/-.

ARMSTRONG
AM/FM Tuner 223 £28 15 0
FM Tuner 224 .... £22 10 0
Carriage and Insurance 7/6.

JASON
FMT1 FM Tuner. Kit of parts £6 15 0
FMT2 FM Tuner. Kit of Parts £10 12 6
FMT3 FM Tuner for fringe Areas:
Kit of parts £12 5 0
FMT4 Tuner £20 0 4
JTV2/FM/TV Sound. Kit of parts £15 15 0
Built and tested .. £21 0 0

QUAD
FM Tuner £24 18 9
Carriage and Insurance 5/- each. Descriptive Leaflets Free on request. Please state model required.

RECORD PLAYERS



Garrard SRP10 Single Player £5 9 1
BSR UA14 Changer.. £5 19 6
BSR UA15 Changer £5 19 6
Garrard Autoslim Autochanger £6 10 0
Magnavox 'Studio" C60 Auto-changer £6 19 6
B.S.R. Super Slim Changer £9 19 6
Garrard AT6 Changer £10 19 6
Garrard AT5 LM Autochanger (3000LM) £11 11 0
Philips AG1016 Stereo/Mono Record Player £12 12 0
Garrard 4HF Single Player £16 17 6
Goldring Lenco Model 88 Transcription Turntable.. £18 18 5
Garrard Laboratory Type "A" Autochanger £19 15 0
Garrard Model 301 Transcription Turntable £20 12 0

Carr. and Ins. 5/- on above.

Descriptive Leaflet including prices with alternative cartridges, dimensions, terms, etc., free on request.

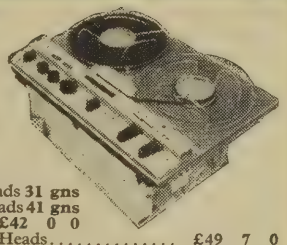
LOUDSPEAKERS

We supply a complete range of Goodmans, Wharfedale, Stentorian, TSL Speaker Units and complete systems. A comprehensive leaflet is available on request, this covers specifications and prices of nearly 50 types including:—
Celestion Model CX2012 (*as illustrated*) £16 10 0
Stentorian HF812 5 watts £3 16 0
Stentorian HF1012 10 watts £4 12 0
Goodmans Axiette 8 6 watts £5 5 7
Goodmans Axiom 10 10 watts £6 5 11
Goodmans Axiom 201 15 watts £10 17 4
Wharfedale Super 8/RS/12/DD 6 watts £6 14 2
Wharfedale Golden RS/DD 8 watts £7 17 5
Wharfedale RS/12/DD 15 watts £11 10 0
Guitar Speakers include:—
Wharfedale W12EG 15 watts £10 10 0
Goodmans Audiom 51B 15 watts £9 2 8
Carriage and Insurance extra.

STERN-CLYNE

ELECTRONIC HOBBIES ORGANISATION

TAPE EQUIPMENT AND ACCESSORIES



Lafayette Stereo Tape Deck with Built-in pre-amplifier (as illustrated) 42 gns. *C. & I.* 15/-
Collaro Studio Tape Deck, ½-track heads £10 10 0
Collaro Studio Tape Deck, ¼-track heads £13 19 6
Truvox D82 Tape Deck with ½-track heads £26 5 0
Truvox D84 Tape Deck with ¼-track heads £29 8 0
Brenell Mk. 5 Series 2 Tape Deck with ½-track heads 31 gns
Brenell Mk. 5 Series 2 Tape Deck with ¼-track heads 41 gns
Wearite Model 5A Tape Deck with ½-track heads £42 0 0
Wearite Model 5S Tape Deck with Stereo Heads..... £49 7 0
C. & I. on above 10/- each.

LAFAYETTE ACETATE TAPE

5in.	600ft.	Standard	8/6
5in.	900ft.	Long Play	10/–
5¾in.	1,200ft.	Long Play	12/6
7in.	1,800ft.	Long Play	15/–

LAFAYETTE MYLAR TAPE

3¾in.	600ft.	Double Play	11/6
7in.	1,200ft.	Standard Play ..	12/6
5in.	1,200ft.	Double Play	15/–
7in.	1,800ft.	Long Play	20/–
5¾in.	1,800ft.	Double Play	22/6
7in.	2,400ft.	Double Play	25/–

BEL-CLEER ACETATE TAPE

5in.	600ft.	Standard	12/6
5in.	900ft.	Long Play	15/–
5¾in.	1,200ft.	Long Play	18/6
7in.	1,200ft.	Standard	18/6
7in.	1,800ft.	Long Play	25/–

Postage & Packing 1/- per Reel extra, 4 or more Reels POST FREE.

We also stock the complete range of Scotch Boy, BASF, Tapes, Accessories etc. Price List free on request.

Fully Automatic Tape Splicer (as illus.) 14/6. P. & P. 1/6.
Plastic Tape Spools, 2¼in. 1/-; 3in. 1/3; 4in. 2/-; 5in. 2/-; 5¾in. 2/3; 7in. 2/6.
Plastic Spool Containers, for spool sizes 5in. 1/6; 5¾in. 2/-; 7in. 2/3.

Any single item plus 6d. P. & P. Orders over £1 POST FREE.
WE CARRY FULLY COMPREHENSIVE STOCKS OF TAPE RECORDERS, DECKS AND ACCESSORIES AT ALL BRANCHES OR ORDER WITH CONFIDENCE BY MAIL.

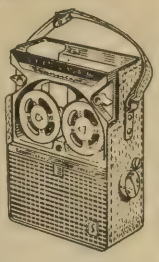
MICROPHONES

Acos Crystal MIC45/1 19 6
Acos "Stick" Microphone, Crystal MIC39-1 .. £1 12 6
DM.303 Dynamic High Impedance Desk Microphone complete with Stand. Metallic green finish ..... 5 gns.
B.M.3 Quality Crystal Microphone with muting switch. Complete with lead, neck harness and removable stand adaptor (matching table stand 12/6 extra). £1 19 6
DX.29 Dynamic High Impedance. Black crackle finish with Desk Stand £2 19 6
DM.301 Dynamic High Impedance with on/off switch. Omni-directional. Chrome plated diecast frame £4 19 6
DM.304 Dynamic Dual High or Low with on/off switch. Satin chrome finish £4 9 6
P. & P. 2/6 extra on all above.

STERN-CLYNE
Electronics Centres throughout Great Britain.— full list over the page

BIG PRICE REDUCTION!

THE STEELMAN TRANSITAPE FROM U.S.A.

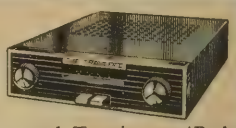


*Fully transistorised. 7 transistors—2 diodes. *2 standard speeds 3¾ and 1⅞ i.p.s. *Over 1 hour on a single reel of tape. *Recording level indicator. *Precision made. *Illuminated overload and battery life indicators ensure uniform quality performance. *Heavy duty 4in. speaker. *Compact size 6½ × 9¾ × 2⅞in. *Wt. under 6½lb. less batteries. Complete with batteries, tape and microphone in solid leather case with shoulder strap. Illustrated instruction manual. Fully guaranteed. ORIGINAL LIST PRICE 55 gns. (less batteries). OUR PRICE **13 GNS.** (including batteries). Plus 7/6 carr. and ins. Limited supply. MAINS UNIT AVAILABLE for operation on 200/250 v. A.C. at 4 GNS. Foot Control switch 29/6. Mike extension lead 5/6.

RADIO CHASSIS BARGAIN!

A 6 valve Superhet Radiogram Chassis of outstanding quality covering M.W. 200-550 metres, L.W. 1,200-2,000 metres, V.H.F. 87-100 Mc/s. Incorporating internal Ferrite Rod Aerial and the famous Gorler Tuning Heart for V.H.F. Pick-up input suitable for most modern Record Players. Power output 4 watts, valve line-up: EZ80, EABC80, EF86, ECH81, EL84, ECC85. Volume On/Off and Tone Control, attractive Tuning Dial size 15×6in. A.C. 200/250 v. Size 15×7¾ × 6½in. Price **16 Gns.** *P. & P. 5/-.* Or £3/9/- Deposit (*Plus P. & P.*) and 9 monthly payments of 32/8. **Also available three wave Band Radio Chassis, size 14½in. × 7½in. × 6½in. Price £9/19/6.** *P. & P. 5/-.* **FEW ONLY.**

THE "TRAVLER" MK. II CAR RADIO



our new ready built transistorised car radio for only **9½ gns.** *P.& P. 5/-*, including 7 × 4in. speaker fitted to baffle, fixing brackets, filter unit, all nuts and bolts with fitting instructions.
STAR FEATURES
*Handsomely Styled *Mullard Valves and Transistors. *Push Buttons. *1½ watts Output. *Long and Medium Wavebands. *Quality Speaker (E.M.I.). *Easily fitted. *Radio Luxembourg (and many other foreign stations). *12-volt Positive Earth only (applies to 99.8% of cars on the road). *Dimensions: 7 × 2 × 7in. depth. Optional extras: 3-section chromium plated weatherproof telescopic aerials type 1, 17in./44in. 19/6. Type 2, 2in./43in. 29/6, both plus p. & p. 2/6 if purchased separately.
Also available: **THE HIGHWAYMAN** Our quality CAR RADIO to build yourself for only **£7/19/6.** *P.&P. 5/-*, full details on request.

TRANSISTORISED SOUND MIXER

Mixing 4 channels from high impedance source giving professional results, inputs for high impedance Microphone, Tuner, Gram and/or Tape Recorder, 9 v. battery operation. Compact and beautifully styled, size 6×2½×2¼in. Standard Jack socket inputs. Price **55/-.** *P. & P. 2/6.*
Complete with PP3 9 v. battery, circuit diagram and instructions. STEREO VERSION available. **Price 72/6.** *P. & P. 2/6.*

STEREO STETHOSCOPE HEADSETS
Enjoy personal listening in absolute comfort with the new lightweight Stethoscope Headsets, suitable for stereo or monaural. Magnetic low impedance. Complete with 6ft. of Cable and Stereo Jack Plug. Price **25/-.** *P. & P. 1/6.*

MONAURAL STETHOSCOPE HEADSETS
Suitable for Radio Tape Recorders, or monitoring tape recordings, magnetic low impedance or Crystal High impedance. Complete with 4ft. of lead and miniature Jack plug. Price **10/6.** *P.& P. 1/6.*

STERN-CLYNE

GREAT BRITAIN'S GREATEST ELECTRONIC HOBBIES ORGANISATION

NOW OPEN!

OUR NEWEST ELECTRONICS CENTRE

AT

125 THE MOOR SHEFFIELD

(Corner of Cumberland Street)

All items available as advertised, together with the finest selection of Hi-Fi, Audio and Tape Recording equipment by all leading manufacturers and a comprehensive range of electronic components for the build it yourself enthusiast. A warm welcome awaits you at Sheffield's latest and most up-to-date electronics centre.

VISIT YOUR NEAREST STERN-CLYNE ELECTRONICS CENTRE

LONDON
18, Tottenham Ct. Rd., W.1. MUSeum 5929/0095. *Half Day Sat.*
23, Tottenham Ct. Rd., W.1. MUSeum 3451/2. *Half Day Thurs.*
309, Edgware Rd., W.2. PADdington 6963. *Half Day Thurs.*
109, Fleet St., E.C.4. FLEet St. 5812/3. *Half Day Sat.*
162, Holloway Rd., N.7. NORth 7941. *Half Day Thurs.*
9, Camberwell Church St., S.E.5. RODney 2875. *Half Day Thurs.*

CROYDON
12, Suffolk House, George St. MUNicipal 3250. *Half Day Wed.*

BRISTOL
26, Merchant Street, Bristol 1. Bristol 20261. *Open 6 days a week*

LIVERPOOL
52, Lord Street. Royal 7450

MANCHESTER
20/22 Withy Grove, Manchester 4. BLAckfriars 5379. *Open 6 days a week*

SHEFFIELD
125, The Moor, Sheffield. Sheffield 29993

MAIL ORDERS AND ENQUIRIES TO:
Dept.W.W. 3-5, Eden Grove, Holloway, London, N.7. NORth 8161/5

CLEAR PLASTIC PANEL METERS

First grade quality, Moving Coil panel meters, available ex-stock. S.A.E. for illustrated leaflet. Discounts for quantity. Available as follows:

Type MR. 38P. 1 21/32in. square fronts.

50μA	32/6	750mA	22/6
100μA	29/6	1A D.C.	22/6
200μA	27/6	5A D.C.	22/6
500μA	25/-	3V D.C.	22/6
50-0-50μA	29/6	10V D.C.	22/6
100-0-100μA	27/6	20V D.C.	22/6
500-0-500μA	22/6	50V D.C.	22/6
1-0-1mA	22/6	100V D.C.	22/6
1mA	22/6	150V D.C.	22/6
2mA	22/6	300V D.C.	22/6
5mA	22/6	500V D.C.	22/6
10mA	22/6	750V D.C.	22/6
50mA	22/6	15V A.C.	22/6
100mA	22/6	50V A.C.	22/6
150mA	22/6	150V A.C.	22/6
200mA	22/6	300V A.C.	22/6
300mA	22/6	500V A.C.	22/6
500mA	22/6	'S' Meter 1mA	29/6

Type MR.52P. 2½in. square fronts.

50μA	57/6	100mA	32/6
100μA	47/6	1A D.C.	32/6
500μA	37/6	300V D.C.	32/6
50-0-50μA	57/6	300V A.C.	32/6
100-0-100μA	47/6	"S" Meter	
1mA	32/6	1mA	39/6

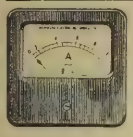
Type MR.85P 3⅝ × 3¼in. fronts

50μA	59/6	1mA	35/-
100μA	49/6	10mA	35/-
500μA	39/6	100mA	35/-
50-0-50μA	59/6	1A D.C.	35/-
100-0-100μA	49/6	300V D.C.	35/-
VU meter	59/6	300V A.C.	35/-

Type MR-85P 4¼in. × 4¼in. fronts

50μA	69/6	1mA	45/-
100μA	59/6	10mA	45/-
200μA	55/-	50mA	45/-
500μA	49/6	100mA	45/-
50-0-50μA	69/6	1 amp D.C.	45/-
100-0-100μA	59/6	3 amp D.C.	45/-
500-0-500μA	49/6	300V A.C.	45/-
1-01mA	45/-	300V D.C.	45/-

POST EXTRA



BAKELITE PANEL METERS

First grade quality 3½in. square fronts.

25μA	65/-	100mA	29/6
50μA	42/6	1A D.C.	29/6
100μA	39/6	5A D.C.	29/6
500μA	35/-	*1A A.C.	29/6
50-0-50μA	42/6	*5A A.C.	29/6
100-0-100μA	39/6	*10A A.C.	29/6
50mv.	39/6	*30A A.C.	29/6
100mv.	39/6	*50A A.C.	29/6
1mA	29/6	300V D.C.	29/6
5mA	29/6	*300V A.C.	29/6
10mA	29/6	300V A.C.	35/-
50mA	29/6	VU Meter	49/6

*Moving iron, all others moving coil.

POST EXTRA.

ILLUMINATED "S" METERS

Cal. in "S" units. 1mA basic. 1 21/32in. sq. front **29/6**. P. & P. 1/-. Ditto, 2 5/16 in. sq. front, **39/6**. P. & P. 1/-.

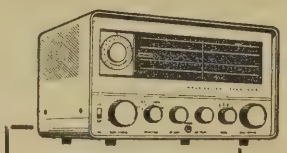
FIELD TELEPHONES 'F'

2-line connection, generator bell ringing. Complete telephone intercom. Supplied fully tested complete with batteries, **£4/19/6** per pair. Carr. 5/-.

DOUBLE BEAM C.R.T.'S. Cossor 89D, **59/6**. P.P. 4/6. Dumont K1051P1. **59/6**. P.P. 4/6.

SEMI-AUTOMATIC "BUG"

Super speed key. 7 speed adjustments. 10WPM to as high as desired. Weight scale for reproductible settings. Precision tooled, anti-rust nickel plated brass and stainless steel operating parts. Size 6¾in. × 3in. × 2¼in. Brand New. **£4/10/-**. P. & P. 2/6.



A SUPERB RECEIVER FOR ONLY £27.10.0

Carriage 10/- extra.

NEW LAFAYETTE COMMUNICATION RECEIVER

MODEL HA. 63

7 VALVES Plus Selenium Rectifier.

4 BANDS covering 550 kc/s—31 Mc/s.

● Illuminated "S" Meter ● 1.5 Microvolt Sensitivity ● Electrical band spread ● Aerial trimmer ● Noise limiter ● B.F.O. ● R.F. stage ● Big slide rule dial ● Output or head phones or 4/8Ω speaker ● Modern steel cabinet size 13in. × 7¾in. × 10in. ● Operation 220/240 volt A.C. S.A.E. for full details. *Supplied Brand New and guaranteed with instruction manual.*

Matching Speaker in Cabinet, **55/-**.

FULL RANGE OF OTHER LAFAYETTE RECEIVERS IN STOCK

MODEL HE-40. 4 Bands, 550 kc/s to 30 Mc/s, **£19/19/-**. Carr. 10/-.

MODEL HE-30. 9 Valves 4 Bands, 550 kc/s to 30 Mc/s, **£35**. Carr. 10/-.

Each receiver supplied brand new and fully guaranteed complete with manual. All models for operation on 220/240 volt A.C. S.A.E. for illustrated leaflet. Generous Part Exchange allowances.

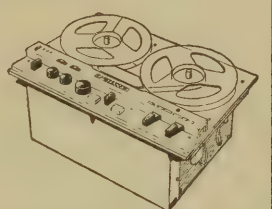
TS-76 20,000 O.P.V. PUSH BUTTON MULTI-TESTER

Large clear plastic scale, simple operation. D.C. volts up to 1,000 v. A.C. volts up to 1,000 v. Resistance up to 10 megohm. Current up to 250 mA. Decibels −20 to +36 db. Size 6in. × 4 3/16 in. × 2¼in. Complete with leads, batteries and instructions. Only **£5/5/-**. P. & P. 2/-.

MODEL DA-1 TRANSISTORISED FULLY AUTOMATIC ELECTRONIC KEYER

230V. A.C. or Battery operated Incorporating built-in monitor oscillator, speaker and keying lever. Fully adjustable speeds giving either auto., semi auto. or hold. 7 transistors, 4 diodes, **£16/10/-**. P. & P. 4/6.

"PROFESSIONAL 4-TRACK STEREO RECORD AND PLAYBACK TAPE DECK



Complete with 4 valve/4 transistor preamplifier. Will record and play back ¼ track stereo or ¼ track mono at 7½ or 3¾ I.P.S. Twin meter level indicators, digital counter. Mic/gram/tuner inputs. Audio output 500 MW Bias and Erase 80 kc. Response 40-18,000 C.P.S. at 7½; 40-12,000 C.P.S. at 3¾ I.P.S. Motor 4 pole H.D. induction. Tape size up to 7in. 220/240 v. A.C. Size 15in. × 10½in. × 6½in. Line up: 4 × 28B173, 2 × 12AT7, 1 × 12AU7, 1 × 12BH7. S.A.E. FOR FULL DETAILS. **PRICE 42 GNS.** CARR. 15/-.

AR. 88 L.F. RECEIVERS

New release. 75-550 kc/s and 1.5-30.5 Mc/s on 6 bands. 110/230 v. A.C. operation. Available in excellent condition, fully tested and checked. **£35** each. Carr. 30/-. A few AR.88D model receivers available in as new condition **£65** each. Carr. 30/-.

MINIFLUX ½-TRACK TAPE HEADS

Set of three, record, playback, erase. Only **29/6** set. P.P. 9d.

ERSKINE TYPE 13 DOUBLE BEAM OSCILLOSCOPE

Time base 2 c/s-750 kc/s. Calibrators at 100 kc/s and 1 Mc/s. Separate Y1 and Y2 amplifiers up to 5.5 Mc/s. Operation 110/230 volt A.C. Supplied in perfect working order. **£27/10/-**. Carriage 20/-.

MULTI-METERS

Brand New—Fully Guaranteed—Lowest ever prices. Supplied with leads, batteries, instructions

MODEL PT-34. 1,000 O.P.V. 0/10/50/250/500/1,000 v. A.C. and D.C. 0/1/100/500 MA. D.C. 0/100 kΩ. **39/6**. P. & P. 1/6.

MODEL 500. 30,000 o.p.v. 0/.5/1/2.5/10/25/100/250/500/1,000V. D.C.
0/2.5/10/25/100/250/500/1,000V. A.C.
0/50μA/5/50/500mA 12 amp. D.C.
0/60K/6 Meg/60 Meg Ω **£8/17/6** Post paid.

MODEL TE-12 20,000 O.P.V. 0/.06/6/30/120/600/1,200/3,000/6,000 v. D.C. 0/6/30/120/600/1,200 v. A.C. 0/60μA/6/60/600 MA. 0/6K/600K/6 Meg./60 Meg. Ω. P.F.-.2 MFD. **£5/19/6**. P. & P. 2/6.

MODEL AR-620 20,000 O.P.V. 0/10/50/250/500/1,000 v. A.C. and D.C. 0/500μA/10/250 mA. 0/10K/100K/1 Meg. Ω. 250 PF—.02 MFD. 0-500 Henrys **92/6**. P. & P. 2/6.

MODEL NH-201 30,000 O.P.V. 0/.25/1/10/50/250/500/1,000 v. D.C. 0/10/50/250/500 v. A.C. 0/50μA/10/250 MA. 0/5K/500K/5 MegΩ. **99/6**. P. & P. 2/6.

MODEL ITI-2. 20,000 O.P.V. 0/5/25/250/500/2,500 v. D.C. 0/10/50/500/1,000 V. A.C. 0/50μA/25/250 mA. D.C. 0/60K/6 Meg. Ω. .01-3 MFD. **82/6**. P. & P. 2/6.

MODEL NH-400 10,000 O.P.V. 0/.3/3/30/120/300/600/1,200 v. D.C. 0/12/60/120/300/1,200 v. A.C. 0/120 μA/30/300 MA. D.C. 0/2K/200K/2 Meg. Ω. 100 PF.—.2 MFD. **79/6**. P. & P. 2/6.

MODEL 250J. 2,000 O.P.V. 0/10/50/500/2,500 V.D.C. 0/10/50/500/2,500 V.A.C. 0/2 Meg Ω. 0/250 mA. −20 to +36 db. **49/6**. P.P. 2/6.

TE-20A R.F. SIGNAL GENERATOR

A precision signal generator of extremely high accuracy and quality. Six ranges from 120 kc/s to 130 Mc/s. on fundamentals with calibrated harmonics from 120 to 390 mc/s. 400 cps. INT. MOD. OR EXT. MOD. OUTPUTS, MOD R.F. UNMOD. R.F. OR 400 c/s audio R.F. output in excess of 100 mv. Large clear 5-inch dial. Handsome grey metal case with handle. Size 7¼in. × 10¾in. × 4¼in. Complete with leads. Operation 220/240 volts A.C. Supplied brand new and guaranteed. **£12/19/6**. Carr. 5/-.

MARCONI TF 144G/4 STANDARD SIGNAL GENERATORS

First release of this late mark. 85 kc/s to 25 Mc/s. ±1%. Output variable from 1μV. to 1 volt. Internal sine wave, modulation 400 c/s up to 75% depth. Operation 200/250 volt A.C. Offered in really excellent condition, like new, fully tested and guaranteed, **£25**. Carr. 30/-.

SILICON RECTIFIERS

250 P.I.V. 750 MA.	3/-
400 v. P.I.V. 3 amp.	7/6
200 v. P.I.V. 6 amp.	5/6
1,000 v. P.I.V. 650mA.	7/6
800 v. P.I.V. 500mA.	5/6
400 v. P.I.V. 500mA.	3/6
200 v. P.I.V. 200 mA.	3/-
95 v. P.I.V. 3 amp.	5/6
70 v. P.I.V. 1 amp.	3/6
150 v. P.I.V. 165mA.	1/-

Discounts for quantities. Post extra.

MINE DETECTOR No. 4A

Will detect all types of metals. Fully portable. Complete with instructions **39/6** each. Carr. 10/-. Battery 8/6 extra.

NEW LOW IMPEDANCE HEADSET

Latest Military type. Rubber moulded fitted with std. jack plug. Brand new boxed. **17/6**. P. & P. 1/6.

MOVING COIL PHONES

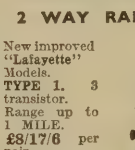
Chamois padded ear muffs, with Jack plug. New, boxed, **22/6**. P.P. 1/6. Ditto with moving coil microphone. **25/-**. P.P. 2/6.

AUTO TRANSFORMERS

Step up or step down. Tapped 0/115/200/230/250V. 20W. **9/-**; 60W. **12/6**; 75W. **15/6**; 150W. **18/6**; 200W. **27/6**; 300W. **42/6**; 500W. **67/6**; 1,000W **90/-**; 1,500W. **£6/19/6**; 3,000W. **£7/10/-**; 7,500W.* **£15**.

(*Only tapped 0/110/230V.) Post extra.

LAFAYETTE HI-FI STEREO HEADPHONES



★ Air cushioned headband ★ Soft rubber ear pads. ★ Frequency response, 25 to 15,000 cycles. ★ High sensitivity. Impedance 8 ohms per phone. Supplied complete with all cables, wires, overload junction box and 3-connection plug. **82/6**. P.P. 2/6.

WALKIE TALKIE 2 WAY RADIOS

New improved "Lafayette" Models.

TYPE 1. 3 transistor. Range up to 1 MILE. **£8/17/6** per pair.

TYPE 2 9 transistor. Range up to 5 miles. **£21** per pair.

Postage extra. S.A.E. for full details.

BEST BUY!

Send 1/- P.O. for full Catalogue and Lists. Open 9 a.m. to 6 p.m. every day Monday to Saturday. Trade supplied.

G.W. SMITH & CO (RADIO) LIMITED

Phone GERRARD 8204/9155
Cables SMITHEX LESQUARE
3-34 LISLE STREET, LONDON, W.C.2

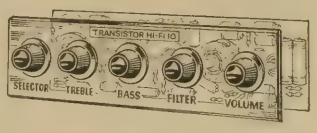
TRANSISTOR HIGH FIDELITY EQUIPMENT

FOR MAINS OR BATTERY OPERATION
10 WATTS OR 20 WATTS

MONO FULL FUNCTION PREAMPLIFIER/ CONTROL UNIT

PRICE **£5-10-0** p.p. 2/-
(or **KIT 99/6**, p.p. 2/-).

★ Dark brown and gold front panel plate **8/6.**



For use with transistor power amplifiers as below or valve amplifiers—hum-free—high sensitivity—8 inputs between 1.5 mV. and 300 mV., with full equalisation. For all pickups—microphones, tuners, tape replay. Separate treble and bass with cut and boost—4 position low pass filter. Volume control, etc. Response within 3dB, 30 c/s to 20 kcs. Output 250 mV. Overall size 9 x 2½ x 2in. Battery operated (2½ mA.) or from power supply. Signal to noise ratio 70 db at 10 watts with power amplifier. Supplied built and ready to use or as a Kit. Attractive appearance and high performance. Can be used to feed one or two Power Amplifiers.

INTEGRATED STEREO PREAMPLIFIER

Two channel version of above with addition of balance and mono/stereo controls. Overall size 9 x 3¼ x 1⅝in. deep. Designed to feed two 10 watt power amplifiers as below. Supplied built and ready to use. Battery-operated (5 mA) or from power supply.

PRICE **£10-19-6** p.p. 3/6.

★ Dark brown and gold front panel plate **12/6.**

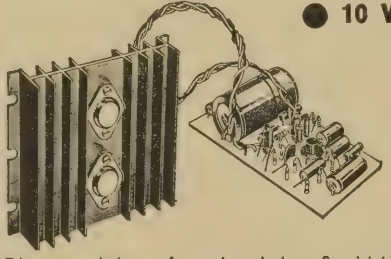
MULTI-INPUT PREAMPLIFIER

For use with any of the transistor power amplifiers or as a general purpose preamp. A simplified version of the full function preamp. 8 inputs from 1.5 mV. to 300 mV. Input selector, tone and volume controls. Size 5 x 2½ x 2in. Ideal for public address systems for microphones and pickups. Suitable to feed one or two Amplifiers.

PRICE **65/-** p.p. 1/6.

★ Dark brown and gold front panel plate **6/6.**

10 WATT POWER AMPLIFIERS



★ 15 ohm 10watt 40 volt supply.

£5-19-6 p.p. 2/6
(or Kit **£5/10/0**, p.p. 2/6).

★ 3 ohm 10watt 24 volt supply

£5-10-0 p.p. 2/6
(or Kit **99/6**, p.p. 2/6).

Direct coupled transformerless design. Sensitivity 100 mV. from 10 K ohm (or less) source for 10 watts output. Response ± 1 db. 40 c/s. to 20 c/s. 0.25% total distortion at 10 watts. Push-pull class B output. 60 db. feedback. Two versions available for 3/4 ohm and 15/16 ohm output. Battery or mains supply operation. For use with mono or stereo preamplifiers as above. Supplied built and ready to use. Or in Kit form.

MAINS POWER PACKS

PS245.	Single amplifier,	24 volt	**59/6**
PS402.	Single amplifier,	40 volt	**59/6**
PS24.	Two amplifiers,	24 volt	**69/6**
PS40.	Two amplifiers,	40 volt	**69/6**

DETAILS WITH CIRCUITS OF ABOVE UNITS ON REQUEST

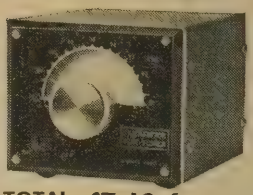
GUARANTEED HIGH PERFORMANCE
LOW NOISE—QUALITY DESIGNS
★ CALL FOR DEMONSTRATION ★

4th EDITION CATALOGUE **2/6** POST PAID

86 pages (size 10 x 7½in.). Packed with hundreds of new items. Price reductions. Fully detailed and illustrated. Transistors—Components—Valves—Crystals—Hi-Fi equipment.
NEW 8-PAGE VALVE, CRYSTAL, TRANSISTOR AND RECTIFIER SUPPLEMENT—FREE ON REQUEST.

SINCLAIR 10 WATT TRANSISTOR AMPLIFIER
IN STOCK. KIT OR BUILT, ALSO MAINS UNIT.

VHF FM TRANSISTOR TUNER



High stability—Low noise—High sensitivity.
★ **5 Mullard Transistors and 4 Diodes.**
★ **Slow Motion Tuning.**
★ **87 to 105 mc/s full coverage.**
★ **1 Volt output.**

Printed circuit design of high sensitivity and quality. Output for valve or transistor amplifiers. Size 3½ x 2¼ x 4in. Simplified building instructions. Operates from 9 volts 9/10 mA. All parts sold separately. Complete with dark brown and gold panel plate.

TOTAL COST £7-19-6 p.p. 2/6.
(Cabinet assembly 20/- extra.)
Detailed Circuit Book on Request.

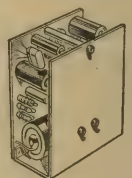
"CONVAIR" TRANSISTOR PUSH-BUTTON PORTABLE CAR RADIO

- **The easiest to build, the most sensitive, clearest output, high selectivity. Guaranteed the best available.**
- **New printed circuit 6-transistor superhet design. Over 700 mW push-pull output.**
- **Push-button selection of MW and LW with full tuning on both wavebands.**
- **Features Mullard Transistors, Double tuned IFT's, Geared Tuning, Hi-Flux Speaker, etc.**
- **New attractively designed portable cabinet with horizontal tuning and all stations marked.**

Total cost of ALL Parts
£7-19-6 p.p. 3/6.
(Batteries 6/- extra.)

ALL PARTS SOLD SEPARATELY. SIZE 10 x 7 x 3½in.
FOLLOWING A LINE OF QUALITY AND VALUE IN PORTABLES

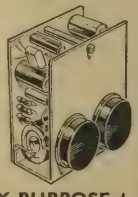
NEW! TRANSISTOR PACKAGED AMPLIFIERS



Two versions, 6-Transistor and Diode Printed Circuit Designs. High Gain Push-Pull Transformerless Output. Overall size only 2½ x 2 x 1½in.

★ **1½ WATT VERSION.** 9 to 12 volts operated. 3 to 5 ohms output. 6mV into 1K ohm, Peak Output 3 watts. 30 c/s to 12 kc/s. Response.

PRICE BUILT 65/- p.p. 1/6. Or **KIT PRICE 57/6** p.p. 1/6.

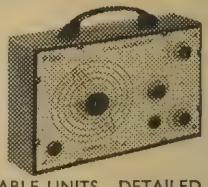


★ **4 WATT VERSION.** 12 to 18 volts operated. 3 to 5 ohms. output. Response 30 c/s to 12 kc/s. 6 mV into 1K ohm. sensitivity. Peak output 8 watts.

PRICE BUILT 79/6 p.p. 1/6. Or **KIT PRICE 69/6** p.p. 1/6.

★ QUALITY COMPACT DESIGNS FOR EVERY PURPOSE ★
Ideal for use with any of our Transistorised Preamplifiers for Mono or Stereo.

TRANSISTORISED TEST EQUIPMENT



★ 150 kc/s to 350 Mc/s generator. RF Mod., AF, 8 ranges. Leads, batt., instructions, **£9/10/0.**
★ Resistance/Capacitance Bridge, **£8/5/0.**
★ Transistorised Power Supply, **£6/10/0.**
★ Audio Generator, **£16/15/0.**
★ Inductance Bridge, **£18/0/0.**

BRAND NEW FULLY GUARANTEED PORTABLE UNITS. DETAILED LEAFLET ON ANY MODEL ON REQUEST.

300 TRANSISTORS, RECTIFIERS, ETC.
500 QUARTZ CRYSTALS
800 VALVES AND TUBES
NEW FREE LIST ON REQUEST

TYPES IN STOCK

HENRY'S RADIO LTD.

303 EDGWARE ROAD, PADDINGTON, LONDON, W.2
PADdington 1008/9.

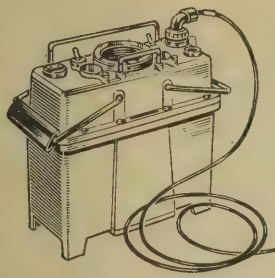
OPEN MONDAY TO SATURDAY 9-6. THURSDAY 1 o'clock.
OPEN ALL DAY SATURDAY.
● ELECTRONIC COMPONENT SPECIALISTS ●
TRADE AND EXPORT ENQUIRIES INVITED.

TRANSISTORS, CRYSTALS, VALVES AND COMPONENTS

● THE LARGEST RANGE OF COMPONENTS IN THE COUNTRY ●

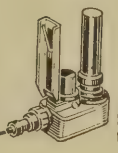
Quotations at competitive prices by return of post. Full catalogue 2/6 Post paid.
Trade and Export enquiries invited.

PORTABLE GEIGER COUNTERS FOR MEASUREMENT OF RADIO-ACTIVITY



offered at a fraction of cost ● Supplied with G5H Tube, for testing Gamma radiation. Supplied complete with instructions, haversack, cables and probe.

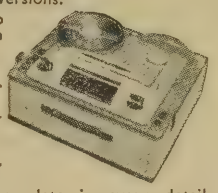
£7.10.0 p.p. 19/-.
(Batteries 50/- extra)



BRAND NEW
M2H Tube for Beta Radiation measurement for liquids 22/6 extra.
★ Plug in EHT unit runs from 1½ volt Penlite cells, 70/-.

● BUILD A QUALITY TAPE RECORDER ●

Available in 2 or 4 track versions.



★ Pre-Built Equipment—6 Valves—Collaro Studio Decks—Portable Cabinets with Speakers.

★ **TWO TRACK PACKAGED DEAL** **£26** p.p. 8/6.
OR Deck 10 gns. P.P. 5/-; Amplifier 11 gns. P.P. 3/6. Cabinet with Speaker 5 gns. P.P. 3/6

★ **FOUR TRACK PACKAGE** **£30** p.p. 8/6.
OR Deck £13/19/6. P.P. 5/-; Amplifier 12 gns. P.P. 5/6. And Cabinet with Speaker 5 gns. P.P. 3/6.

All complete in every detail. Illustrated leaflets on request. Ideal for portable or domestic equipment.

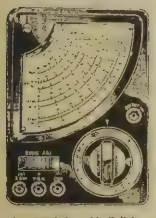
MULLARD POT CORES

LA1	12/6	LA4	12/6	LA9	17/6	LA2503	15/-
LA2	15/-	LA5	17/6	LA10	17/6	LA2504	15/-
LA3	19/6	LA6	22/6	LA45	15/-	LA2505	17/6

FM VHF TUNING HEART

Printed circuit construction. RF stage and osc./mixer stage, fully tunable 85 to 105 Mc/s. Completely screened. Requires UCC85 (8/6). Brand new in maker's cartons 15/-. P.P. 1/-.
SUPPLIED WITH CIRCUIT.

MULTIMETERS—NEW LOW PRICES



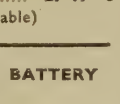
Multi-range test meters featuring easy to read scales and provided with full operating instructions, lead and batteries. Suitable for amateurs, designers, repair shops, all domestic uses. Full details and specification in our catalogue.

★ PT34, 1kΩ/V	£1	19	6
★ M1, 2kΩ/V	£2	9	6
★ THL33, 2kΩ/V (illus.)	£3	15	0
★ EP10K, 10kΩ/V*	£3	19	6
★ ITI-2, 20kΩ/V	£4	2	6
★ TP5S, 20kΩ/V*	£5	19	6
★ EP30K, 30kΩ/V*	£5	10	0
★ 500, 30kΩ/V*	£8	19	6
★ EP50K, 50kΩ/V*	£8	10	0
★ EP100K, 100kΩ/V	£9	19	6

(*Leather Cases Available)

GARRARD TWO TRACK BATTERY TAPE DECK

Two speed two track 9 volt operated. Brand new complete with rec./play head, and combined erase/osc. coil. Supplied with cassette and full manual. **£11/15/-.** P.P. 3/6.



MICROPHONES

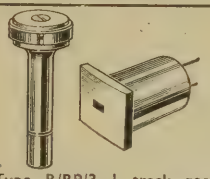
(See Catalogue for details)

Acos 60 Stick Microphone	19/6
Acos 39-1 Stick Microphone	32/6
Acos 40 Desk Microphone	15/-
Acos 45 Hand Microphone	19/6
Lapel/Hand Microphone	12/6
Acos Stick Microphone	15/-
100C Stick with Stand	32/6
BM3 Stick with Stand	49/6
Lapel/Hand Magnetic	8/6
MM71 2k Mag. Mic	12/6

A SELECTION FROM OUR STOCKS

See Catalogue for full details.

RECORD/REPLAY/ERASE TAPE HEADS



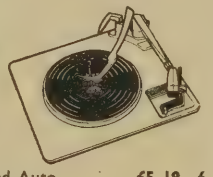
Marriot Type R/RP/3 ¼ track record-replay head and Mullard type TS erase head with mounting post. Impedance 700 ohms at 1Kc/s. Ideal for transistor circuits. Bargain Offer. **15/- Pair.**

Sinclair Micro-6 (to build)	59/6
Sinclair TR750 Amplifier (to build)	39/6
Sinclair Micro Injector (to build)	27/6
Sinclair 10 watt 9 trans. Amp. Kit	£5-19-6
Sinclair 10 watt 9 trans. Amp. Kit, built	£8-19-6
Tape Jack Tuner (Full Med. Wave)	29/6
10-Watt Horn Tweeter CT10	27/6
20-Watt Super Tweeter CT20	69/6
Two-channel Mixer for Mics/Pu's	15/-
1 to 200 Mc/s Field/str. Meter	59/6
5-hole Chassis Punch Kit	49/6
Headphones 2kΩ 12/6; 4kΩ	14/6
Stereo Stethoscope Headset, 8+8 arm	25/-
Resistor Substitution Box	32/6
Crystal Mono Stethoscope Headset	10/6
Magnetic Mono Stethoscope Headset	12/6
Transistor Signal Injector	35/-
4-channel Transistor Mixer	49/6
Fully Disappearing Car Aerial	35/-
Test Lead Kit with Pouch	8/6
Capacitor Substitution Box	22/6
De Luxe Stereo Headsets with junction box	£6
PP3 9V Batt. Eliminator	18/6
Transistor Telephone Amplifier	59/6
8+8Ω Stereo Headphones	62/6
VTVM Valve Voltmeter	£13-19-6
100 Mc/s RF Probe for above	£2-2-0
Crystal Contact Microphone	12/6
2kΩ ¼ track Tape Head	15/-
2kΩ 3in. diam. Mag. Mic. Insert	15/-
MC1 Crystal Mic. Insert	5/-
Earphones, Crystal or Magnetic Complete with Jack and Socket.	5/-
Telephone Recording Attachment	9/6
50-0-50μA Edgwise Meter	25/-
6/12V Min. 2p2w 675 ohm Relay	12/6
Transistor Coil Set with Tuner, Ferrite Aerial and Circuit	20/-
30W Pocket Mains Solder Iron	14/6
8in. P-M+ 15/16 ohm Speaker	69/6
100 Kc/s Quartz Crystal	15/-
Twin Crystal 1 Kc/s and 100 kc/s	22/6
3 Transistor mW Superhet Tuner	67/6

WIRELESS WORLD 10-TRANSISTOR CRYSTAL CONTROLLED FM TUNER

All parts in stock. Total cost **£8/19/6.** P.P. 2/-. Complete with printed circuit & layout diagram. (Set of 3 crystals 80/- extra),
All parts sold separately—List on request.

MAINS AND BATTERY RECORD PLAYER DECKS



Complete with arm and cartridge. Brand new fully guaranteed.

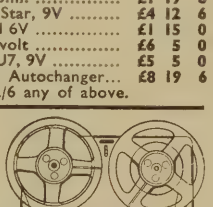
★ BSR UA14 4-speed Auto.	£5	19	6
★ BSR UA15 4-speed Auto.	£6	19	6
★ Garrard Autoslim, unplugable head, Auto.	£6	19	6
or Stereo Version, Auto.	£7	19	6
★ SRP10 4-speed or BSRGU7	£5	0	0
★ Garrard AT6 with Stereo Cartridge, 4-speed Auto.	£10	19	6
★ AT6 with EV26 or Sonotone head	£11	19	6
★ AT6 with Mono head, Auto.	£10	10	0

P. & P. 3/6 any type above.

★ 9 volt Star, 45 r.p.m.	£1	19	6
★ 45 and 33 r.p.m. Star, 9V	£4	12	6
★ 45 r.p.m. Garrard 6V	£1	15	0
★ SRP10 4-speed 9 volt	£6	5	0
★ 4-speed B.S.R. GU7, 9V	£5	5	0
★ Autoslim 6/9 volt Autochanger...	£8	19	6

P. & P. 2/6 any of above.

COLLARO-STUDIO TRANS-CRIPTOR TAPE DECKS



Brand new, fully guaranteed.

★ **TWO TRACK** **10** Gns.

★ **FOUR TRACK** **£13.19.6** Post and packing 5/- either type

QUALITY MICROPHONES

Large range of magnetic and crystal microphones in stock from 8/6.
(See Catalogue for full range)

100c Crystal stick with Stand	£1	2	6
BM3 Crystal stick with Stand	£2	9	6
MC70 Crystal Studio	£2	2	0
DM16HL Dual impedance	£4	9	6
DM17HL Dual impedance stick	£4	2	6
Adjustable Table Stand (P.P. 2/-)	£1	5	0
FS3 Telescopic Floor Stand (P.P. 3/6)	55/-		

Cintel All Transistor Counter up to 1 Mc/s. PRICE **£125.**

QUARTZ CRYSTALS

100 Kc/s. 3 Pin...	15/-	10 Mc/s. 2 Pin ...	15/-
500 Kc/s. 2 Pin ...	15/-	27.255 Mc/s. Radio	
455 Kc/s. (AR88)	12/6	Control	15/-
HRO 456 Kc/s....	15/-	Twin Crystals	
5,000 Kc/s. 2 Pin	10/-	100kc/s. & 1 mc/s.	22/6

Over 600 frequencies in stock. Latest crystal lists free on request.

ZENER REFERENCE DIODES

★ IN430 8 to 8.8 volt, 0.2% stability from −55°C to +100°C **45/-** each.

★ IN249 5.9 to 6.4 volt, 1% stability from −55°C to +100°C **15/-** each.

● **GS10CS Dektron Display Tubes 25/-.** Base 2/-. GS12C Tube **25/-.**
● **931A Photomultipliers, 60/-,** with base.
● **89D (CV2193) Double Beam 'Scope Tube 59/6.**
● **09D (CV1596) 59/6.**
Large range of special purpose types in stock.

CATHODEON MINIATURE CRYSTAL OVEN

6 or 12 volt A.C./D.C. 80°C. for HC6U or 2M crystals.
Brand new.
22/6.

Henry's Radio Ltd.

303 EDGWARE ROAD, LONDON, W.2.
PADdington 1008/9
Open Monday to Sat. 9-6. Thurs. 1 o'clock.

TRIPLETONE HI-FI MAJOR £15.18.9

12 watts 15 to 20,000 c.p.s. 5 valves A.C. mains isolated. 12in. x 5¾in. x 6in. high. Built-in pre-amp. and mixer. Two inputs and volume controls. Sensitivity mic. 10 mV.; Gram 250 mV. 3 tone controls, Bass, Treble and Middle. Auxiliary power supply. 250 v. D.C. 6.3 v. A.C. Cabinet with handle, 30/- extra.

New R.C.S. VALVES 90-day guarantee.

IR5	6/-	6N7M	5/-	EBC81	5/-	PCF82	8/-
IS5	6/-	6Q7G	6/-	EBF80	5/-	PCL82	10/-
IT4	3/-	6SN7	5/-	ECH42	9/-	PCL84	5/-
2X2	2/-	6V6G	5/-	ECH81	9/-	PCL86	10/-
3S4	7/-	6X4	5/-	ECL80	9/-	PL81	10/-
3V4	7/-	6X5	6/-	ECL82	10/-	PL83	8/-
3Q5	7/-	12AT7	6/-	ECL86	10/-	PY80	7/-
5U4	6/-	12AU7	6/-	EF86	10/-	PY81	8/-
5Y3	6/-	12AX7	7/-	EF89	8/-	PY82	7/-
5Z4	9/-	12K7	5/-	EF183	7/-	SP61	3/-
6AM6	4/-	12K8	14/-	EF184	7/-	U22	7/-
6AT6	6/-	12Q7	5/-	EL84	7/-	UBC41	8/-
6BA6	7/-	35L6	9/-	EY51	9/-	UBC81	5/-
6BE6	5/-	35Z4	5/-	EY86	9/-	UBF89	5/-
6H6	3/-	954	2/-	EZ40	5/-	UCH81	9/-
6J5	5/-	DAF96	8/-	EZ80	7/-	UCL82	10/-
6J6	5/-	DF96	8/-	EZ81	7/-	UCL83	12/-
6J7G	6/-	DK96	8/-	HVR2A	5/-	UF89	5/-
6K6GT	5/-	DL96	8/-	MU14	7/-	UL41	9/-
6K7G	5/-	EABC80	5/-	PC97	7/-	UY41	5/-
6K8G	5/-	EB91	4/-	PCC84	8/-	UY85	7/-
6L6G	8/-	EBC41	8/-	PCF80	5/-		

NEW ELECTROLYTICS FAMOUS MAKES

TUBULAR		TUBULAR		CAN TYPES	
1/350 v.	2/-	50/350 v.	5/6	8/600 v.	9/-
2/350 v.	2/3	100/25 v.	2/-	16/600 v.	12/-
4/350 v.	2/3	250/25 v.	2/6	16/450 v.	5/-
8/450 v.	2/3	500/12 v.	3/-	16+16/500 v.	7/6
16/450 v.	3/-	1,000/12 v.	3/-	50/450 v.	6/6
32/450 v.	3/9	5,000/6 v.	5/-	32+32/350 v.	5/-
25/25 v.	1/9	8+8/450 v.	3/6	32+32/450 v.	6/-
25/50 v.	2/-	8+16/450 v.	3/9	50+50/350 v.	7/-
50/25 v.	2/-	16+16/450 v.	4/3	64+120/350 v.	11/6
50/50 v.	2/-	32+32/350 v.	4/6	100+200/275 v.	12/6

TINNED COPPER WIRE 16 to 22 s.w.g., ¼ lb. 3/-.
ENAMEL WIRE ½lb. 16 to 22 s.w.g., 2/9, 24 to 30 s.w.g. 3/6. 32 to 40 s.w.g., 4/6. D.C.C. 28, 34, 36 s.w.g., 3/6 2 oz.

CRYSTAL MIKE INSERTS. High output.

Miniature size, 1½in. dia. x ⅜in.	6/6
ACOS MIKE INSERT 1½ x ⅜in.	8/6
ACOS STICK MIKE 39-1	35/-
T.S.L. DE LUXE STICK MIKE	25/-
TELEPHONE CONTACT MIKE	10/6
GUITAR CONTACT MIKE	15/6
Moving Coil Mike 90/-, Floor Stand	57/-
TANNOY CARBON MIKE	7/6

VALVE HOLDERS. EA50 6d. B12A, CRT, 1/3. Eng. and Amer. 4, 5, 6 and 7-pin 1/-. Printed circuit B9A B7G, Int. Oct. 1/-. MORSE KEY 4/6; BUZZER 4/6.
MOULDED Int. Oct. or Mazda Oct. 6d.; B7G, B8A, B8G, B9A 9d. B7G with can 1/6. B9A with can 1/9. Ceramic EF50, B7G, B9A, Int. Oct. 1/-. B7G, B9A cans, 1/- each. Valve base plugs B7G, B9A, Int. Oct. 2/3.

MARTIN TAPE PRE-AMPLIFIERS

(PLAY-BACK THROUGH YOUR OWN AMPLIFIER)
FOR 2 TRACK COLLARO DECKS 8 GNS.

MARTIN COMPLETE RECORDING AND PLAYBACK AMPLIFIERS
FOR 2 TRACK COLLARO £11/11/-.

TAPE DECKS Collaro 2-Track £10/15/-. B.S.R. 2-Track £7/5/-.

HEADPHONES, 2,000 ohms 12/-. 4,000 ohms 15/- pair. HEADPHONES, moving coil 100 ohms 10/- pair.
SWITCH Cleaner Fluid, squirt spout, 4/6 tin.

C.R.T. BOOSTER TRANSFORMERS

For T.V. Tubes having heater Cathode short circuit and for T.V. Tubes with low emission, full instructions. Mains input.
LOW LEAKAGE WINDINGS WITH OPTIONAL 0%, 25% or 50% BOOST ON SECONDARY.
2 V. OR 4 V. OR 6.3 V. OR 10.3 V. OR 13.3 V. (State Tube voltage required) ea. **10/6**

SPEAKER-FRET. Gold, Green or Maroon Cloth 17×25in. 5/-; 25×35in. 10/-. Tygan various colours, 52in. wide from 10/- ft.; 26in. wide from 5/- ft. Samples 1/-.
EXPANDED METAL, Gold, 12 × 12in., 6/-.
TYGAN 12 × 12in. 2/-.

MINIATURE PANEL METERS

Size 1¾in. sq. Precision jewelled bearings, 2% accuracy, silvered dials, fine pointers, 0-1 mA. 27/6; 0-5 mA. 27/6; 0-300 V. 27/6; 0-50μa 39/6; 0-500μa 32/6. "S" meter 35/-.

MOVING COIL MULTIMETER TK20A. 0-1000 v. A.C./D.C. ohms .0-100k, etc., 0-150 mA Pocket size 2in. scale. 49/6.

MAINS TRANSFORMERS
200/250 AC Post 2/- each

STANDARD 250-0-250, 80 mA. 6.3 v. 3.5 a., tapped 4 v. 4 a. Rectifier 6.3 v. 1 a. tapped 5 v. or 4 v. 2 a.	22/6
Ditto 350-0-350	29/6
MINIATURE 200 v. 20 mA., 6.3 v. 1 a.	10/6
MIDGET 220 v. 45 mA., 6.3 v. 2 a.	15/6
SMALL. 250-0-250 v. 45 mA., 6.3 v. 2 a.	17/6
STANDARD 250-0-250 65 mA., 6.3 v. 3.5 a.	17/6
HEATER TRANS. 6.3 v. 1½ a.	7/6
Ditto tapped sec. 1.4 v., 2, 3, 4, 5, 6.3 v. 1½ amp.	8/6
HEATER TRANS. 6.3 v. 4 a.	10/6
GENERAL PURPOSE LOW VOLTAGE. Outputs 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 24 and 30 v. at 2 a.	22/6
AUTO TRANS. 150 w., 0, 115 v. 200, 230, 250 v.	22/6
AUTO TRANS. 500 w. 0, 115, 200, 230, 250 v.	32/6
MULLARD "510" MAINS TRANS. TO SPEC. 300-0-300 120 ma., 6.3 v. CT 4a., 0, 5, 6.3 v. 2 a.	33/6

O.P. TRANSFORMERS. Heavy duty 50 mA., 5/6. Small, pentode, 4/6. Miniature 3V4, etc., 5/9. Multi-ratio 7/6. Multi-ratio heavy duty push-pull 7 to 10 w., 18/6.
Goodmans heavy duty 10/20 w. 6K push-pull, 30/-.
Estone ultra-linear OT/ML 10 w., Spec. for "510" 45/-. 10 w. matching transformer, 3, 7, 15 ohms, 12/6.
INTERVALVE TRANSFORMERS. 3 : 1, 5 : 1, 9/- each.
L.F. CHOKES 15/10 H., 60/65 mA., 5/-; 10 H., 85 mA., 10/6; 10 H., 120 mA., 12/6; 10 H. 150 mA. 14/-.

465-470 Kc/s SIGNAL GENERATOR

Price 10/6. R.F. and Audio Output Ready made. POCKET SIZE 2½in. × 4½in. × 1in. Only one resistor to change. Instructions supplied. Battery 8/6. Details free.

FULL WAVE BRIDGE CHARGER RECTIFIERS, 2, 6, or 12 V. 1½ a., 8/9; 2 a. 11/3; 4 a. 17/6; 6 a. 22/6.
CHARGER TRANSFORMERS. Tapped input 200/250 v., for charging at 2, 6 or 12 v., 1½ a., 15/6; 2 a., 17/6; 4 a. 22/6. Free charger circuit. Ammeter 0-5 a., 10/6.

BOOKS (List S.A.E.)

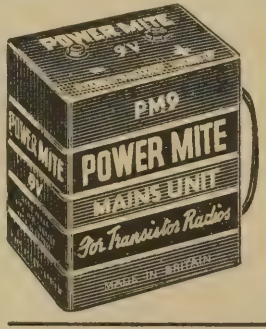
"W.W." Radio Valve Data	7/6
High Fidelity Speaker Enclosures	5/-
Valves Transistors, CRT Equivalents	9/6
At a Glance Valves, CRT Equivalents	3/6
TV Fault Finding	5/-
Mullard Audio Amplifier Manual	8/6
Radio Valve Guide, Books, 1, 2, 3, or 4 ea.	5/-
Practical Radio Inside Out	3/6
Master Colour Code	1/6
Coil Design and Construction Manual	5/-
Radio, TV and Electronics Data Book	3/6
International Radio Stations List	2/6
Boys' Book of Crystal Sets	2/6
Stroboscopic Disc 33, 45, 78 r.p.m.	1/-
How to Receive Foreign T.V.	5/-

CRYSTAL DIODES. G.E.C. 2/-; GEX34, 3/-; OA81, 3/-.
CRYSTAL COILS HAX, 3/6; HAXL 3/6; DRE2 4/6.
CRYSTAL SET BOOKLET 1/-. CRYSTAL SET KIT 12/6.
BRIMISTORS CZ1 3/6; CZ2 2/6; CZ3 1/6; CZ11 4/-.

MAINS POWER PACKS.

Ready built with Mains Transformers, Rectifiers and Condensers etc., providing H.T. and L.T.
200 v. 20 mA. D.C. ½ wave 6.3 v. 1 a. A.C. **25/6**
220 v. 50 mA. D.C. ½ wave 6.3 v. 2 a. A.C. **35/6**
250 v. 80 mA. D.C. Full wave 6.3 v. 4 a. A.C. **45/6**

TRANSISTOR TYPES. 9 v. Same size as battery PP3 **19/6**. PP9 **45/-** (also replaces PP1, PP4, PP7). As illustrated below.



9 volts **45/-** MAINS POWER YOUR TRANSISTOR

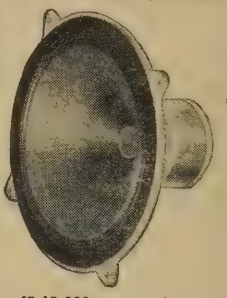
ADASTRA 3-3 Hi-Fi AMPLIFIER READY BUILT, WIRED AND TESTED

A.C. 200-250 V. Valves ECL86 and EZ80. 3 ohms 3 watts. Controls: bass boost, treble and volume. Separate engraved front-panel. Quality mains transformer. Chassis size 6in. x 5in. x 3in. Price £5/9/6. Details S.A.E.
"Performs agreeably well." (The GRAMOPHONE).

BAKERS 'Selhurst' RADIO

12" STALWART HEAVY DUTY 15w.

with LIFETIME GUARANTEE—5 gns.



Cast aluminium frames—no resonance — steel magnet assembly, bolted together — no riveted or glued innaccessible parts

45-13,000 c.p.s., 3 or 15 ohm voice coils. Unlimited Applications. Flat response 100 to 10,000 c.p.s. magnet 12,000 lines. Price for quality unbeatable. Foam Suspension Ign. extra (10w rating).

BAKERS SELHURST FULL RANGE 1965 MODELS

8in. Junior special 8w. 40/20 kc/s. 15Ω 5 gns.
12in. Guitar 25w. 15 ohms 5gns.
12in. Stereo, foam suspension, 15 ohms. 7 gns.
12in. Standard H.D. 20w. 40-14,500 c.p.s. 7 gns.
12in. De Luxe foam. 15 w. 25-17,000 c.p.s. 15,000 Lines, Bass Res. 32-38 9 gns.
12in. Bass 25 w. 25-15,000 c.p.s. 12 gns.
12in. Super Twelve, 20 c.p.s. to 25 kc/s 16 gns.
15in. Auditorium 35 w. Mk. II Bass Res. 36-42 17,000 lines, ideal for guitars, etc. 18 gns.

LOUDSPEAKERS. PM 3 OHM FAMOUS MAKES. 2½in., 3in., 4in., 5in., 6in. × 4in., 15/6 each 8in. 17/6; 6½in., 16/6; 10in. 30/-; 12in. 30/-; 15 ohms 35/-. 10in. × 6in., 22/6; 8in. × 5in., 9in. × 6in., 21/-.
E.M.I. Double Cone 13 × 8in., 10 w., (Ceramic) 45/-.
Horn Tweeter 104 dB. 2 Kc/s. to 16 Kc/s. 29/6. Crossover 3000 c.p.s. 30/-; 10in. HF1012, 87/6; 8in. HF812 72/6.
TWIN GANG CONDENSERS "0-0" Transistor 208 pF and 176 pF. with trimmers and screen 10/6 each; 365 pF. miniature 1⅛ × 1½in. × 1⅜in. 10/-; 500 pF standard with trimmers, 9/-; midget, 7/6; midget with trimmers, 9/-; 500 pF slow motion drive, standard, 9/-. Small 3-gang 500 pF., 17/6. Single "0" 365 pF, 7/6.
SHORT WAVE. Single 10 pF., 25 pF., 50 pF., 75 pF., 100 pF. 160 pF., 5/6 each. Can be ganged together. Couplers 9d. each.
VERNIER DIALS. Ratio 8:1 1⅛in. 12/6. 2in. 14/-. 3in. 16/-
TUNING AND REACTION CONDENSERS. 100 pF., 300 pF., 500 pF. 3/6 each, solid dielectric.
CONDENSERS. 0.001 mfd., 7kV. T.C.C. 5/6; ditto 20 kV. 9/6; 0.1 mfd. 7 kV., 9/6; Tubular 500 v. 0.001 to 0.05 9d.; 0.1 1/-; 0.25 1/6; 0.1/350 v. 9d.; 0.5/350 v., 1/9; 0.01/2,500 v. 1/9; 0.1/2,000 v. 3/6.
CERAMIC CONDENSERS. 500 v. 1 pF. to 0.1 mfd., 9d. High voltage pulse ceramics 100 pF., etc., 12 kV., 2/6.
SILVER MICA. 10% 5 to 500pF., 9d.; 600 to 3,000 pF. 1/-; close tolerance (plus or minus 1 pF.), 2.2 to 47 pF., 1/-; ditto 1% 50 to 815 pF. 1/-; 1,000 to 5,000 pF., 1/9.

TRANSISTOR 4 CHANNEL MIXER with 4 separate input-output controls, 59/6.

WAVE-CHANGE SWITCHES
2 p. 2-way, or 2 p. 6-way, long spindle 3/6
3 p. 4-way, or 1 p. 12-way, long spindle 3/6
4 p. 2-way, or 4 p. 3-way, long spindle 3/6
8 p. 4-way, 2 wafer, long spindle 6/6
Wavechange "MAKITS" Wafers available; 1 p. 12-way, 2 p. 6-way, 3 p. 4-way, 4 p. 3-way, 6 p. 2-way. Prices include click spindles, adjustable stops, 1 wafer, 8/6; 2 wafer, 12/6; 3 wafer, 16/-. Extra wafers up to 12, 3/6 each.
TOGGLE SWITCHES. s.p., 2/-; d.p. 3/6; d.p.d.t., 4/-.
Rotary Toggles, s.p., 3/6; d.p. 4/6. Min. Slide d.p. 3/6.
JACKS. English open-circuit 2/6, closed-circuit 4/6. Grundig type 3-pin 1/3; Grundig Lead Type 3/6. Phono Plugs 1/-. Socket 6d. Banana Plugs 1/-. Sockets 1/-.
JACK PLUGS ENGLISH Screened 3/-. Grundig 3-pin 3/6.
BULGIN NON-REVERSIBLE PLUGS and SOCKETS. P74 2-pin 4/3; P73 3-pin 4/6; P194 6-pin 6/6.
P360 3-pin 4/-; Mains selector panel with plug 1/-.

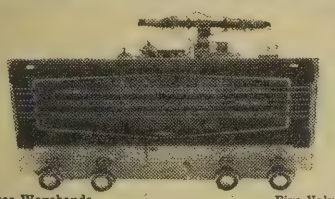
RETURN OF POST MAIL ORDER SERVICE

RADIO COMPONENT

Our written guarantee with every purchase. Buses 133 and 68 pass door. S.R. Stn. Selhurst

FOR — IMMEDIATE — DESPATCH — PHONE — US — TODAY

1964 RADIOGRAM CHASSIS



Three Wavebands — Five Valves
S.W. 16 m.-50 m. — Latest Mullard etc.
M.W. 200 m.-500 mm. — ECH81, EF89, EBC81,
L.W. 800 m.-2,000 m. — EL84, EZ80
12-month guarantee. A.C. 200-250 v. 4-way switch. Short-Medium-Long-Gram. Ferrite Aerial. A.V.C. and Negative Feedback. 5 watts 3 ohm. Chassis 13½in. × 7in. high × 5in. deep. Glass dial size 13in. × 4in. horizontal wording. Two Pilot Lamps. Four Knobs. Aligned and calibrated. Chassis isolated from mains.

BRAND NEW £9.15.6 Carr. 4/6.
Matched Speakers 8in. 17/6; 10in. 25/-; 12in. 30/-.

Volume Controls

Long spindles. Midget
5K ohms to 2 Meg.
L/S 3/-. D.P. 4/6.

Stereo L/S 10/6. D.P. 14/6.
Linear or Log Tracks.

80 Ohm CABLE Coax

Semi-air spaced 6d. yd.
40 yd. 17/6, 60 yd. 25/-.
Low loss 5dB per 100ft. at 500 mc/s.
Ideal 625 lines 1/6 yd.

CAR AERIAL 15/3. PLUGS 1/6. Ditto sockets 1/3.
COAXIAL PLUG 1/-. TRIPLEXERS Bands I, II, III 12/6.
PANEL SOCKETS 1/-. LEAD SOCKETS 2/-.
COAX. OUTLET BOXES. SURFACE OR FLUSH 4/-.
BALANCED TWIN FEEDERS 6d. yd., 80 or 300 ohms.
TWIN SCREENED FEEDER 1/- 80 ohms.
EXTENSION SPKR. CONTROL, 10 ohms 3/-; 25 ohms 6/6.
TELESCOPIC CHROME AERIALS. 12in. extends to 33in. 8/6 each. T.V. AERIAL B.B.C. and I.T.V. 15/-.
RESISTORS. Preferred values. 10 ohms to 10 meg.
¼ w., ½ w., 1 w. 4d.; 1½ w., 8d.; 2 w., 1/-.
HIGH STABILITY. ½ w. 1% 2/-. Preferred values, 10 ohms to 10 meg. Ditto 5%, 10 ohms to 22 meg., 9d.

5 watt	WIRE-WOUND RESISTORS	1/3
10 watt		1/6
15 watt	10 ohms 10,000 ohms	2/-
12.5 K to 25K, 10 w.		3/-

I.F. TRANSFORMERS 7/6 pair
465 kc/s. Slug Tuning Miniature Can. 2 1×1in.
High Q and good band width. Data sheet supplied.

WIRE-WOUND Pots. 3 WATT. Pre-set Min. T.V. Type. All values 10 ohms to 25K, 3/- ea., 30K, 4/-; Carbon 30K to 2 meg., 3/-.

WIRE-WOUND 4-WATT STANDARD SIZE POTS. LONG SPINDLE VALUES 50 OHMS to 50K, 6/6; 100K, 7/6.

TRIMMERS. Compression ceramic 30, 50, 70 pF, 9d.; 100 pF, 150 pF, 1/3; 250 pF, 1/6; 600 pF, 750 pF, 1/9; Phillips 0 to 10 pF, 3 to 30 pF, 1/- each. T.V. etc. 1000 pF, with knob, 2/-; RADIO SCREWDRIVER, 5in., 6d.
Bulgin Test Prods 2/9 ea. Neosid Trimming tools 1/9.
NEON MAINS TESTER-SCREWDRIVER, 5/-.
SOLDER MULTICORE 4d. yd. SAVBIT DISPENSER 2/6.

HIGH GAIN TV. PRE-AMPLIFIER BAND 1 B.B.C.
Tunable channels 1 to 5. Gain 18 dB. ECC84 valve. Kit price 29/6 or 49/6 with power pack. Details 6d. (PCC84 valves if preferred for 0.3a heater chains).
BAND III I.T.A. —same prices.
Tunable channels 7 to 13. Gain 17 dB.
Coils and circuit only, 9/6. Chassis 4/9. Band I or III.

PAXOLIN PANELS. 1/16in. × 10in. × 8in. 2/-.
RECTIFIERS. RM1 5/-; RM2 6/-; RM3 8/-; RM4, RM5, 14A100, 14A116 10/- each; K3 25, 800 v. 5 mA. 5/-.
MINIATURE CONTACT COOLED RECTIFIERS. 250 v., 60 mA., 7/6; 250 v. 85 mA., 9/6; 200 mA., 21/-; 300 mA., 27/6; Full Wave Bridge 250 v. 75 mA., 10/-; 120 mA., 15/-.
Silicon 250 v. 450 mA., 10/-. Silicon 250 v. 150 mA., 5/6.
SELENIUM RECT. Popular type. 300 v. 85 mA., 5/-.
COILS Wearite "P" type. 4/- each.
Repanco. DRR2 L. and Med. T.R.F. reaction, 4/6 ea.
OSMOR MIDGET "Q" type. adj. dust core, from 4/- each.
FERRITE AERIALS (VALVE) M. 8/9; M.L. 12/6.
FERRITE ROD AERIALS. L. and M. for transistor circuits.
OSMOR 10/- each. WEYRAD 12/6 each.
FERRITE RODS 8×⅜in. 3/-; 6×⅜in. 3/-; 6×5/16in. 3/-.

QMAX CHASSIS CUTTER

The cutter consists of four parts; a die, a punch, an Allen screw and key.

⅛in.	14/6	1⅛in.	18/-	2in.	34/3
¼in.	14/6	1¼in.	18/6	2 5/16in.	37/9
⅜in.	15/6	1 5/16in.	20/-	2½in.	44/9
½in.	15/9	1⅜in.	20/-	1in. sq.	31/6
⅝in.	18/-	1½in.	20/6	1 1/16in. sq.	28/-
1 1/16in.	18/-	1½in.	22/6		

Famous Manufacturers Surplus Bargain
Ferguson Quality Amplifier 4 Watts
Size 6½ x 5 x 4in. 200-250 AC double wound mains transformer. Volum and tone controls. Sensitivity 200 mv. Response 25 to 20,000 cps. Price with valves, etc. **49/6** *each. Complete Brand new. 2 units matched for stereo etc., 89/6.*

H.F. CHOKES, all wave, 2/6. Osmor QC1, 6/9.
T.R.F. COILS A/HF, 7/- pair.
DUST CORES 1in., 4d. Purple Cores ½in. 6d.
ALADDIN FORMERS and cores, ¼in. 8d., ⅜in., 10d., 0.3in. FORMERS 5937 or 8 and cans TV1 or 2, ¼in. sq. × 2½in. or ½in. sq. × 1½in., 2/- with cores.

BLANK ALUMINIUM CHASSIS. 18 s.w.g. 4 sides, riveted corners, lattice fixing holes. 2½in. sides, 7×4in., 5/6; 9×7in., 6/6; 11×8in. 6/6; 11×7in. 7/6; 13×9in., 9/6; 14×11in. 12/6; 15×14in., 15/-.
ALUMINIUM PANELS. 18 s.w.g. 12×12in., 5/6; 14×9in., 4/6; 12×8in., 3/6; 10×7in., 2/9; 8×6in., 2/-; 6×4in., 1/6.

SLOW MOTION DRIVES. Epicyclic ratio 6-1, 4/3. 36:1, 10/6.
SOLON IRON 25 w. 200 v. or 230 v., 24/-. 65 w. 29/-.
A.N.T.E.X. PRECISION sub-miniature iron. 200 or 240 v. 32/6. Stands for A.N.T.E.X. irons 12/6 extra.

4 TRANSISTOR AMPLIFIER 47/6
Size 4 × 1⅞ × ⅞in.
Powerful ready built push-pull. Output 3 and 8 ohm. Ideal for use with record players, intercoms., or "BABY ALARM" with instructions and circuit. 9 v. Batt. 2/6. 2½" Speaker 15/6.

MAINS DROPPERS. Midget. With adj. sliders.
0.3A 1,000 ohms, 6/- 0.15A 1,500 ohms, 6/-
0.2A 1,200 ohms, 6/- 0.1A 2,000 ohms, 6/-
Line Cord 100 ohms ft 0.2 amp. 3-way 1/- ft.

BARGAIN SINGLE PLAYER KIT 200/250v. A.C.
£5.15.0 (less cabinet) **post 5/-**
WITH 2-STAGE AMPLIFIER 3-WATT
HIGH-FLUX 5in. SPEAKER,
4-SPEED B.S.R. TURNTABLE
CRYSTAL PICK-UP FOR L.P. & 78
Cut out Mounting Board 12⅛ × 9¼in.

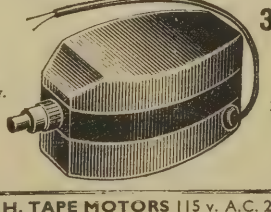
ARDENTE TRANSISTOR TRANSFORMERS
D3035, 7.3 CT:1 Push Pull to 3 ohms for OC72, OC81 11/-
D3034, 1.75 : 1 CT. Push Pull Driver for OC72, OC81 11/-
D3058, 11.5:1 Output to 3 ohms for OC72, OC81 .... 11/-
D239, 4.5:1 Driver, ¼in. × ½in. × ½in. 11/6
D240, 8.5:1 Driver ¼in. × ½in. × ½in. 11/6
ARDENTE TRANSISTOR VOLUME CONTROLS
VC1545, 5K with switch, 5/3.
DEAF AID EARPIECE Xtal or magnetic. 7/6.
SUB-MIN. JACK and PLUG, 3/6 pair. 2.5 mm. or 3.5 mm.
MIKE TRANSFORMERS 50:1 3/9.

PLASTIC RECORDING TAPE

Double Play	7in. reel, 2,400ft.	42/-	Spare Spools
	5in. reel, 1,200ft.	25/-	3in. .. 1/6
Long Play	7in. reel, 1,800ft.	22/6	4in. .. 2/-
	5½in. reel, 1,200ft.	17/6	5in. .. 2/-
	5in. reel, 900ft.	15/-	5½in. .. 2/-
			7in. .. 2/6
Standard	7in. reel, 1,200ft.	17/6	Leader Tape 4/6
	5in. reel, 600ft.	11/6	Splicer Tape 3/-
"EASYSPLICE" Tape Splicer 5/-.			Stop foil 7/3.

P.V.C. CONN. WIRE, single or stranded, 2d. yd.
SLEEVING 1 or 2 mm., 2d.; 4 mm. 3d.; 6 mm., 5d. yd.
Bib Cutters 3/6. Insulated Side Cutters, 8/6.
Panel mounting fuse-holders 2/-. Fuses 60 mA. to 5 a., 6d.
Screws 6BA, 4BA, 6d. doz. Nuts 6BA, 4BA 6d. doz.

THE "INSTANT" BULK TAPE ERASER AND RECORDING HEAD DEMAGNETIZER

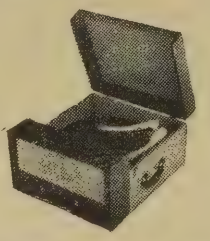


200/250 v. A.C. **35/-** Leaflet S.A.E.

B.T.H. TAPE MOTORS 115 v. A.C. 28w. 12/6 pair, for 230 v. (in series)

BUILD YOUR OWN RECORD PLAYER

FROM £9.19.6 AND SAVE POUNDS



4 Speed Autochange or Single Player units with Brand New 2-tone Cabinets 17×15×8½in. Strong handle, gilt finish, clips and hinges. As used by Famous Make for 20 gns. models. Cut-out motor board 14×13in. Front baffle with 7×4in. high flux loudspeaker and 3 watt 2 valve UY85, UCL82 2-stage amplifier ready built on metal chassis 12×3×2½in. Quality output transformer, low hum level circuit. Volume and Tone controls, 3 core safety mains lead. All items fit together perfectly. Special instructions enable assembly in 30 minutes, only 5 wires to join. 12 months' written guarantee. Available separately or package deals as below:

AUTOCHANGE KITS Complete—as above.

B.S.R. Monarch	£11/10/-	P.P.	5/-
Garrard Autoslim	£12/18/-	P.P.	5/-

SINGLE PLAYER KITS Complete—as above.

B.S.R. Junior	£9/19/6	P.P.	5/-
Garrard SRP10 auto stop/start	£11/15/-	P.P.	5/-

OR SEPARATELY

Cabinet with board 14×13in. cut out to your choice free of charge.	£3/9/6	P.P.	3/6
Amplifier with 7×4in. speaker	£3/17/6	P.P.	3/6

AUTOCHANGERS (Stereo Mono 20/- extra)

B.S.R. UA12-UA14 Mono ..	£5/19/6	P.P.	3/6
B.S.R. UA15 Slimline Mono..	£6/17/6	P.P.	3/6
Garrard Autoslim Mono	£6/17/6	P.P.	3/6

SINGLE PLAYERS,

Garrard SRP 10 auto stop/start	£5/5/-	P.P.	3/6
E.M.I. auto stop/start	£5/5/-	P.P.	3/6
B.S.R. Junior	£3/7/6	P.P.	3/6

TRANSCRIPTION UNITS

Philips AG1016 Stereo/mono..	£12/5/-	P.P.	5/-
Garrard 4HF Mono xtal	£15/15/-	P.P.	5/-
Garrard AT6 Mono xtal	£10/10/-	P.P.	5/-

All units £1 extra with Stereo/mono xtals.

Replacement sapphire stylii.....5/- diamond 15/-
Replacement Xtals from 15/-; Stereo from 30/-
The Dust Bug Record Cleaner 20/6

FAMOUS MAKERS SURPLUS BARGAIN XTAL PICK-UP ARM
Complete with ACOS LP-78 Turnover xtal and two Sapphire Stylii 20/-.

NEW MULLARD TRANSISTORS

OC71 6/-, OC72 7/6, OC81D 7/6. OC81 7/6, AF115 10/6, AF114 11/-, OC44 8/-, OC45 8/-, OC171 9/-, OC170 8/6, AF117 9/6. Transistor Holders 1/3.
Sub Miniature Condensers. 0.1 mFd., 30 v., 1/3. 1, 2, 4, 5, 8, 16, 25, 30, 50, 100 mFd., 15 volt 2/6 each.

"6+1" TRANSISTOR RADIO

First-class components to make a 6-transistor 2-waveband superhet chassis. Ideal for portable or table radio. All parts including BVA transistors, ferrite aerial, printed circuit. 8½ × 2½in., but EXCLUDING speaker and cabinet. 35 ohms output. Simple instructions 1/6 (free with kit).
Speakers 35 ohm., 7×4in., 21/-. **£4.5.0**
5in., 17/6; 3½in., 15/6. Cabinet 27/6.

WEYRAD

TRANSISTOR SUPERHET TRANSFORMERS, COILS PRINTED CIRCUIT. 6in. FERRITE ROD AERIAL Long and Medium—RA2W with CAR AERIAL COIL. 208 pF. tuning 12/6
Oscillator Coil, P50/1AC, 176 pF tuning..... 5/4
1st and 2nd I.F. Transformers—P50/2CC, 470 Kc/s. 7/16in. diameter by ⅜in. high, each 5/7
3rd I.F. P50/3CC diode detector 6/-
Drive Transformer—LFDT4 ..... 9/6
Printed Circuit—PCA1, 2½in. × 8½in. Drilled 9/6
Jackson "OO" gang 208+170pF, with trimmers 10/6
Volume control 5K, D.P. 4/6
35 ohm Speakers 3½in. 15/6. 5in. 17/6. 7×4in. 21/-
Wavechange Switch' 3/6
Set of 6 Mullard Transistors and diode 42/6
Constructors' Booklet with full details 2/-
3 ohm Output Transformers OPT1 ..... 10/6

B.B.C. 2 TRANSISTOR + DIODE —22/6
M.W. and L.W. Radio Kit. Earpiece 7/6; Battery 2/3. Circuit and Details 6d. Real performance.

SINCLAIR "SLIMLINE" 49/6
Med. wave kit. 3 × 1½ × ⅞in. Includes earphone, printed circuit. Ferrite Rod. Guaranteed no aerial required.

SINCLAIR "MICRO-6" 59/6
2 × 1½ × ½ complete kit.

perts answer all enquiries.

SPECIALISTS

OUR ONLY ADDRESS
337 WHITEHORSE ROAD
WEST CROYDON *Telephone* THO 1665

P. charge 1/-, Full list, 1/-, C.O.D. 2/- extra. (Export welcome. Send remittance and extra postage, no C.O.D.)

R.S.C. Post Orders to R.S.C. (M/C) Ltd., 54 Wellington St., Leeds, 1. Trade Supplied. Personal Shoppers to any of Branches below: **R.S.C.** Post Terms. C.W.O. or C.O.D. No C.O.D. under £1. Postage 2/9 extra on orders under £2. 4/6 extra under £5 unless carr. stated. **R.S.C.**

LEICESTER	BIRMINGHAM	SHEFFIELD	HULL	M'CHESTER	LIVERPOOL	LEEDS	BRADFORD
33 High Street (Half day Thurs.)	6 Gt. Western Arcade (*opp. Snow Hill Stn.*) (No half day)	13 Exchange Street (Castle Market Buildings) (Half day closing Thursday)	51 Savile St.	8-10 Brown Street (Market Street) (No half day)	73 Dale Street 8 *mins. from Lime St. Stn.* (No half day)	5-7 County (Mecca) Arcade, Briggate. Leeds, 1 (No half day)	56 Morley Street (*above Alhambra*) (Half day Wed.)

BRISTOL OPENING 5th OCT.

14, LOWER CASTLE STREET. (Half-day W dnesday)

HI-FI 10 WATT AMPLIFIERS

BRAND NEW CARTONED MANUFACTURER'S DISCONTINUED MODEL **£7 . 19 . 6** Carr. 4/6

A REMARKABLE OPPORTUNITY. Push-pull output. Latest high efficiency Mullard valves. Dual separately controlled inputs for mike and gram. Separate base and treble controls. High sensitivity. Output for 3 ohm or 15 ohm loudspeaker. Guaranteed tested and in perfect working order. For 200-250 A.C. mains.

LINEAR TAPE PRE-AMPLIFIER Type LP/1. Switched negative feedback equalisation. Positions for Record 1¾in., 3¾in., 7½in. and Playback. EM84 Recording Level indicator. Designed primarily as the link between Collaro Tape Transcriptor and high fidelity amplifier but suitable almost any Tape Deck. **9 GNS.** Send S.A.E. for leaflet.

LINEAR L45 MINIATURE 4/5 W. QUALITY AMPLIFIER. Suitable for use with any record playing unit and most microphones. Negative feedback 12 D.B. Bass and treble controls. For A.C. mains input of 200-250 v. 50 c.p.s. Output fo 2/3 ohms speaker. Three miniature Mullard Valves. Size only 6×5×5¼in. high. Chassis fully isolated from mains. Guaranteed 12 months. Only **6 GNS.** OR Deposit **23/6** and 5 monthly payments of **23/6.** Send S.A.E. for leaflet.

R.S.C. POWER PACKS 200-250 v. A.C. Completely enclosed in louvred enamelled case, 8×5½×2½in. Output fully smoothed 250 v. 60 mA. and 6.3 v. 2 a. **39/9.**

SUPERHET RADIO FEEDER UNIT

Design of a high quality Radio Tuner (specially suitable for use with any of our Amplifiers). Triode Heptrode, F changer is used. Pentode I.F. and double Diode Second Detector. Delayed A.V.C. W. Ch. Sw. incorporates Gram. position. Controls are Tuning, W. Ch. and Vol. Simple alignment instructions. Only 250 v. 15 mA. H.T. and L.T. or 6.3 v. 1 amp. required from amplifier. Size of unit approx. 9-6-7in. high. Send S.A.E. for illustrated leaflet. Total building cost of **5 GNS.** Point-to-point wiring diagrams and instructions **2/6.**

W.B. "STENTORIAN" HIGH FIDELITY P.M. SPEAKERS. HF1012. 10 watts rating. Where a really good quality speaker at a low price is required, we highly recommend this unit with an amazing performance. **£4/12/-.** Please state whether 3 ohm or 15 ohm required.

BASS REFLEX CABINET. Designed for above speaker. Acoustically lined and ported. Polished walnut veneer finish. Size 18×12×10in. Strongly made. Handsome appearance. Ensures superb reproduction for only **£3/19/6.**

STOCKISTS OF ARMSTRONG CHASSIS, GOODMANS, W.B., and FANE SPEAKERS, LINEAR, LEAK, VERDIK, ROGERS, DULCI AMPLIFIERS, GARRARD and GOLDRING TURNTABLES *CASH or H.P.*

THE SKYFOUR T.R.F. RECEIVER

A design of a 3-valve 200-250 v. A.C. mains L and M. wave T.R.F. receiver with selenium rectifier. It employs valves 6K7, 8P61, 6V6 and is specially designed for simplicity in wiring. Sensitivity and quality are well up to standard. Point to Point wiring diagram, instructions and parts list **1/9.** This receiver can be built for a maximum of **£4/19/6** including veneered walnut cabinet.

Only 3 pairs of soldered joints plus mains.

AUDIOTRINE HI-FI TAPE RECORDER KIT

Build a high quality recorder in the £70 class for only

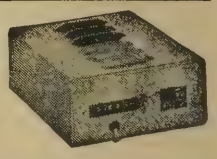
25½ GNS. Carr. 17/6. Can be assembled in 1 hour Send S.A.E. for leaflet **OR DEPOSIT £2.13.9** and 12 monthly payments of 44/6 Cash price if settled in 3 months.

INCORPORATING THE LATEST COLLARO STUDIO TAPE TRANSCRIPTOR THE AUDIOTRINE HIGH QUALITY TAPE AMPLIFIER. A HIGH FLUX 7×4in. LOUDSPEAKER. Reel of Best Quality TAPE, Spare Tape Spool, a Portable Cabinet, size approx. 14½ × 15 × 8½in., finished in complementary shades of rexine and Vynair and connection diagram for wiring amplifier to transcriptor.

FEATURES INCLUDE:

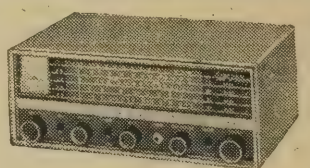
★ 3-SPEEDS ★ FREQUENCY RESPONSE 50-11,000 c.p.s. ★ SWITCHED NEGATIVE FEEDBACK EQUALIZING FOR EACH SPEED ★ OUTPUT 4 WATTS ★ MAGIC EYE RECORDING LEVEL INDICATOR ★ 3 MOTORS ★ Fast rewind ★ TAPE MEASURING AND CALIBRATING DEVICE ★ TAKES FULL 7in. DIAMETER REELS OF TAPE ★ NEGLIGIBLE HUM ★ ENTIRELY EFFECTIVE AUTOMATIC ERASURE.

R.S.C. BATTERY TO MAINS CONVERSION UNITS



Type BM1. An all-dry battery eliminator. Size 5½ × 4½ × 2in. approx. Completely replaces batteries supply 1.4 v. and 90 v. where A.C. mains 200-250 v. 50 c/s. is available. **Suitable for all battery portable receivers requiring 1.4 v. and 90 v.** Complete kit with diagram **39/9,** or ready for use **46/9.** Type BM2. Size 8 × 5½ × 2½in. Supplies 120 v. 90 v. and 60 v. 40 mA. and 2 v. 0.4 a. to 1 amp., fully smoothed **THEREBY COMPLETELY REPLACING BOTH H.T. BATTERIES AND L.T. 2 v. ACCUMULATORS** when connected to A.C. mains supply 200-250 v. 50 c/s. SUITABLE FOR ALL BATTERY RECEIVERS normally using 2 v. accumulator. Complete kit with diagrams and instructions. **49/9** or ready for use **59/6.**

COMMUNICATION RECEIVERS



HE-40 De-Luxe 4 Band. 220/240 v. 50/60 c.p.s. A.C. mains operation. Frequencies covered 550 Kc/s. to 50 Mc/s. continuous. Incorporates 5in. speaker. Slide rule tuning dial. "S" meter. Internal ferrite aerial for medium wave. Telescopic whip aerial 59in. 10 section for short waves. Fitted sockets for optional outdoor aerial. Headphone, external speaker Socket. Other features are electrical bandspread tuning, 0-100 logging scale. Noise limiter. A.V.C. B.F.O. stand by switch. Size approx. 14×8½×5½in. Handsome grey crackle finished metal cabinet with chromium fittings. Brand new with full instructions manual. Usual guarantee. **TERMS:** Deposit **£3/15/-** and nine monthly payments of **52/3.** Cash price if cleared in 3 months. **Only £24.15.0** Carr. Free.

HE-30 4 Band. Continuous coverage 550 Kc/s. to 30 Mc/s. Illuminated slide rule dial. Edgewise "S" meter. 0-100 logging scale. Built in "Q" multiplier aerial trimmer, electrical bandspread, noise limiter, controls are: Function switch, audio gain, selectivity, frequency (B.F.O.). Band selector, I.F. gain, trimmer, A.V.C./M.V.C. Switch. ANL switch, main tuning, bandspread tuning Output for h/phones or standard speaker. Provides 1.5 watts output. For 220/240 v. 50/60 c.p.s. A.C. mains. A highly efficient receiver representing exceptional value at only **40 GNS.** Post Free.

Size 15 × 10 × 7¾in.

TERMS: Deposit **£5/4/-,** and nine monthly payments of **91/2.** Cash price if settled in 3 months.

R.S.C. STEREO/TEN HIGH QUALITY AMPLIFIER KIT

Valves EZ81, ECC 83, ECC83, EL84, EL84. Separate base and treble controls giving "cut" and "boost" Sensitivity 50 mV. 5 watts high quality output on each channel. Can be used as straight 10 watt amplifier. Controls: Stereo/Monaural switch ganged volume, ganged treble, ganged bass and balance. Output for 3 ohms speaker. Point-to-point wiring diagrams and instructions. Illustration full wiring details and priced parts list **1/9.** Or supplied assembled and tested **59/6** extra. **8 GNS.** Carr. 7/9.

R.S.C. 3 WATT GRAM AMPLIFIER KIT

All parts to build a compact, highly sensitive amplifier suitable for any single or autochange player. Size 12 × 2½ × 2½in. Double wound. Mains transformer for 200-250 v. A.C. mains. Output for 2-3 ohm speaker. Volume and tone control with switch. **39/9**

SELENIUM RECTIFIERS

L.T. Types	
2/6 v. ½ a. H.W...	1/9
6/12 v. ½ a. H.W...	2/9
Following F.W. (Bridge)	
6/12 v. 1 a.	3/11
6/12 v. 2 a.	6/11
6/12 v. 3 a.	9/9
6/12 v. 4 a.	12/3
6/12 v. 5 a.	14/6
6/12 v. 6 a.	15/6
6/12 v. 10 a.	25/9
6/12 v. 10 a.	35/9

R.T. Types H.W.	
120 v. 40 mA.....	3/9
250 v. 50 mA.....	3/11
250 v. 60 mA.....	4/11
250 v. 80 mA.....	6/11
250 v. 250 mA.	11/9
Types Below Contact cooled	
250 v. 60 mA. H.W.	5/11
250 v. 70 mA. H.W.	7/11
F.W. (Bridge) Types	
250 v. 50 mA.....	8/11
250 v. 75 mA.....	10/11

ACOS GP67-2G HI-FI Crystal Cartridges with sapphire stylus. Standard replacement for Garrard, B.S.R. and Collaro. Only **16/9.** Acos Stereo/Monaural **35/9.** Ronette. Stereo/Monaural **39/9.**

TRANSISTOR SALE

Mullard OC71 **3/9.** OC45 **4/11.** OC44 **4/11.** OC72 **4/9.** OC81 **4/11.** OC171 **8/9. Ediswan** XA101, XA112, XB113, XB104, XC101A, **3/9** ea. Postage 6d. for up to 3 Transistors.

JASON F.M. TUNERS

Type FMT1. All parts including Dial. Escutcheon, Punched Chassis and Valves. Power supply required 180 v. 25 mA. and 6.3 v. 1.5 a. **£6/19/6**

Type FMT2 ..... **£8/19/9**

R.S.C. Battery Chargers & Kits for 200-230-250 v. 50 c/s. A.C. Mains Guaranted 12 mths.

HEAVY DUTY KIT

6/12 v. variable charge rate up to **6 amps.** Consisting of Mains Trans. F.W. (Bridge), Selenium Rectifier, 0-7 amp. meter. Variable Charge Selector. Fuses, fuse-holders, panels, plugs and circuit. Only **59/9.** Post 4/6.

TRANSFORMERS

200-230-250 v. 50 c/s.

0-9-15 v.	1½ a.....	12/9
0-9-15 v.	2½a.....	14/9
0-9-15 v.	3 a.....	16/9
0-9-15 v.	**5 a.....**	19/9
0-9-15 v.	6 a.....	23/9
0-9-15 v.	8 a.....	28/9

BATTERY CHARGER KITS

Consisting of Mains Transformer, F.W. Bridge, Metal Rectifier, well ventilated steel case. Fuses, fuse-holders, grammets, panels, clips and circuit. Carr. 3/9 extra.

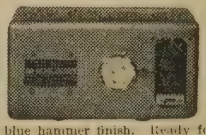
6 v. or 12 v. 1 amp.	22/9
As above with ammeter.....	28/9
6 v. 2 amps......	19/9
6 v. or 12 v. 2 amps......	25/9
6 v. or 12 v. 2 amps......	35/9
(inclusive of ammeter)	
6 v. or 12 v. 4 amps. with variable charge rate selector and ammeter	52/9

ASSEMBLED CHARGERS

6-12v.1a. less meter **27/9**

6-12 v. 2 amp. Fitted Ammeter and selector plug for 6 v. or 12 v. Louvred metal case, finished attractive hammer blue. Ready for use with mains and output leads. Double Fused. Only **39/9** Carr. 3/9.

ASSEMBLED 6v. or 12 v. 4 amps.



Fitted Ammeter and variable charge selector. Also selector plug for 6 v. or 12 v. charging. Double fused. Well ventilated steel case with blue hammer finish. Ready for use with mains and output leads. **59/9** Carr. 4/6.

Or Deposit **12/-** and 5 monthly payments of **12/-.** As above but for 6 amp. charging **4 GNS.** Carr. 5/-. or Deposit **16/-** and 5 monthly payments of **16/-**

HEAVY DUTY 14 AMP. KIT

at 12 v. (or 24 v. at 7 amp.). Consists of Transformer. Rectifier, Variable Resistor, Ammeter Fuses, Terminals, Stove Enamelled Case and Circuit. Only **10 GNS.** Carr. 15/-.

HEAVY DUTY 12 v. 10 AMP. KIT

Consists of Mains Transformer, F.W. (Bridged) Selenium Rectifier, Ammeter, Fuses, Variable Resistor, and Circuit. For 200-250 v. A.C. mains. Only **£4/19/9,** carr. 10/-.

EX GOVT. SELENIUM RECTIFIERS

12 v. 15 amps. F.W. (Bridge). **Only 19/9**

EX. GOVT. SMOOTHING CHOKES

60 mA. 10 h. 400 ohms **3/11.** 100 mA. 10 h. 100 ohms. **6/9.** 150 mA. 10 h. 100 ohms **10/11.** 120 mA. 12 h. 100 ohms **9/9.** 200 mA. 5-10 h. 100 ohms **11/9.** 250 mA. 5 h. 50 ohms **10/9.**

TANNOY 8 WATT RE-ENTRANT LOUDSPEAKERS.

8 ohms for workshop, factory or outdoor use **25/9** ea.

VALVES

Full range. Keen prices

CHARGER AMMETERS

0-1½ a., 0-3 a., 0-7 a. **8/9.**

SENSATIONAL STEREO OFFER

Complete kit of parts to construct a 3+3 watt good quality stereo amplifier providing realistic reproduction. Suitable all stereo pick-up leads. Ganged vol. and tone controls. Pre-set balance. For 200-250 v. A.C. mains only. Fully isolated chassis. **4 GNS.** Carr. 4/6.

Or including Stereo Head **19/9** extra.

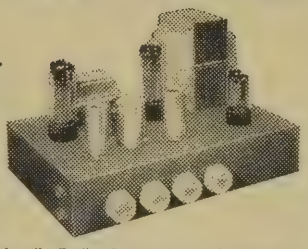
R.S.C. BABY ALARM or INTERCOM. UNIT KIT

For 200-250 v. A.C. mains. Includes all parts, diagrams and instructions. High sensitivity. Completely safe. Controllable at other end. Housed in two cabinets of pleasing design **89/6.** Carr. 5/-. Or assembled and tested **6 GNS.**

DERBY 96 Osmaston Rd., The Spot (*Half day Thurs.*) | **LONDON** 238 Edgware Rd. (*Half day Thurs.*) | **EDINBURGH** 133 Leith St. (*Half day Wed.*) | **GLASGOW** 326 Argyle St. (*Half day Tues.*) | **MIDDLESBROUGH** 106 Newport Rd. (*Half day Wed.*) | **DARLINGTON** 13 Post House, Wynd (*Half day Wed.*)

R.S.C. A10 30 WATT AMPLIFIER

HIGH FIDELITY ULTRA LINEAR PUSH-PULL OUTPUT



SIX VALVES EF86, EF86, ECC83, 807, 807, GZ34. Tone Control Pre-Amp. stages are incorporated. Sensitivity is extremely high. Only 12 millivolt minimum input is required for full output. **THIS ENSURES THE SUITABILITY OF ANY TYPE OR MAKE OF MICROPHONE OR PICK-UP.** Separate Bass and Treble controls give both "lift" and "cut" with ample tone correction for long playing records. An extra input with associate vol. control is provided so that two separate inputs such as "mike" and gram. etc., can be simultaneously applied for mixing purposes. **AN OUTPUT SOCKET WITH PLUG IS INCLUDED FOR SUPPLY OF 300 v. 20mA. and 6.3 v. 1.5 A. FOR A RADIO FEEDER UNIT.** Price in kit form with easy to follow wiring diagram. ONLY **11 Gns.** Carr. 10/-. Or factory built using latest EL34 output valves and with 12 months' guarantee. **14 GNS. TERMS ON ASSEMBLED UNITS. DEPOSIT 33/9** and 9 monthly payments of **33/9.** Protective Cover **19/9.** Type 807 output valves are used with High Quality Sectionally Wound output transformer specially designed for Ultra Linear operation. Negative feedback of 20 D.B. in main loop. **CERTIFIED PERFORMANCE FIGURES ARE EQUAL TO MOST EXPENSIVE UNITS AVAILABLE.** Frequency response ± 3 D.B. 30-20,000 c/s. Tone Controls ± 12 D.B. at 50 c/s. + 12 D.B. to −6 D.B. at 15,000 c/s., hum and noise 70 D.B. down. Good quality reliable components used. Chassis finish gold hammer. Overall size 12×9×9in. approx. Power consumption 150 watts. For A.C. mains 200-250 v. 50 c/s. Output for 3 and 15 ohms speakers. **EQUALLY SUITABLE FOR THE CONNOISSEUR OR FOR LARGE HALLS, CLUBS OR OUTSIDE FUNCTIONS. IDEAL FOR USE WITH MUSICAL INSTRUMENTS, SUCH AS STRING BASS, ELECTRONIC ORGAN, GUITAR, etc. FOR DANCE BANDS, GARRISON THEATRES, etc., etc. We can supply Microphones, Speakers, etc., at keen cash prices or on terms with amplifiers. EXPORT ENQUIRIES INVITED.**

LOUDSPEAKERS. 2½in. to 18in. at keen prices. 12in. 6-8 watt 3 ohms **29/11.** 12in. 10 watt 12,000 lines 3 ohms or 15 ohms. **59/9. TWEETERS.** 4in. R.A. 3 ohms **25/9.** R.A. 15 ohms **25/9.** W.B. 15 ohms **32/3.** Fane 15 ohms, Pressure type **£3/15/-.**

POWER PACK KITS. Fully smoothed output 250 v. 60 mA. H.T. and L.T. 6.3 v. 1.5 amps. Consists of chassis, mains Trans. 200-250 v. Double wound, Rectifier, Choke, Electrolytics and circuit.

FANE HIGH FIDELITY SPEAKERS

All with exceptionally robust 2in. diameter voice coil assemblies.

12in. 15 ohms. Cast chassis: HEAVY DUTY.

12/10 20 watts .. **5 gns.**	12/10A 20 watts .. **6 gns.**
12/12 20 watts .. **7 gns.**	12/12A 20 watts .. **8 gns.**
12/14 22 watts .. **9 gns.**	12/14A 22 watts .. **10 gns.**
12/17 25 watts .. **£11 17 6**	12/17A 25 watts **£12 17 6**

15in. 15 ohms. Cast chassis: HEAVY DUTY.

15/12 20 w..... **12 gns.**	15/12A 20w. .... **13 gns.**
15/14 27w..... **14 gns.**	15/14A 27w. .... **15 gns.**
15/17 35w..... **16 gns.**	15/17A 35w. .... **17 gns.**

"A" indicates dual cone type 30-17,000 c.p.s. Send S.A.E. for leaflets. Terms available.

R.S.C. A5 4-5 WATT HIGH GAIN AMPLIFIER

A highly sensitive 4-valve quality amplifier for the home, small club, etc. Only 50 millivolts input is required for full output so that it is suitable for use with the latest high fidelity pick-up heads in addition to all other types of pick-ups and practically all makes. Separate Bass and Treble controls are provided. These give full long playing record equalisation. Hum-level is negligible being 71 D.B. down. 15 D.B. negative feedback is used. H.T. of 300 v. 26 mA. and L.T. of 6.3 v. 1.5 a. is available for the supply of a Radio Feeder Unit or Tape Deck pre-amplifier. For A.C. mains input of 200-250 v. 50 c/s. Output for 2-3 ohms speaker. Chassis is not alive. Kit is complete in every detail and includes fully punched chassis (with baseplate) with the blue hammer finish and point-to-point wiring diagrams and instructions. Exceptional value at only **£4/15/-** or assembled ready for use **25/-** extra. plus 3/6 carriage. Or deposit **22/-** and five monthly payments of **22/-** for assembled unit.

R.S.C. TRANSFORMERS Fully Guaranteed. Interleaved & Impregnated.

MAINS TRANSFORMERS. Primaries 200-250 v. 50 c/s.

FULLY SHROUDED. UPRIGHT MOUNTING.

250-0-250v. 60mA., 6.3 v. 2 a. 0-6-6.3 v. 2a. 2½-3-3in.	17/11
250-0-250 v. 100 mA., 6.3 v., 4 a., 0-5-6.3v. 3 a.....	28/9
300-0-300 v. 100 mA., 6.3 v. 4 a., 0-5-6.3 v. 3 a....	28/9
300-0-300 v. 130 mA., 6.3 v. 4 a. c.t., 6.3 v. 1 a. For Mullard 510 Amplifier	35/9
350-0-350 v. 100 mA., 6.3 v. 4 a., 0-5-6.3 v. 3 a...	29/9
350-0-350 v. 150 mA., 6.3 v. 4 a., 0-5-6.3 v. 3 a....	37/9
425-0-425 v. 200 mA., 6.3 v. 4 a., c.t., 5 v. 3 a....	57/9
425-0-425 v. 200 mA., 6.3 v. 4 a., 6.3 v. 4 a., 5 v. 3 a.	59/9
450-0-450 v. 250 mA., 6.3 v. 4 a. C.T. 5 v. 3 a.....	69/9

TOP SHROUDED DROP-THROUGH TYPE

260-0-256 v. 70 mA., 6.3 v. 2 a., 0-5-6.3 v. 2 a.....	17/9
250-0-250 v. 100 mA., 6.3 v. 3.5 a.....	19/9
250-0-250 v. 100 mA., 6.3 v. 2 a., 6.3 v. 1 a.....	21/9
350-0-350 v. 80 mA., 6.3 v. 2 a. 0-5-6.3 v. 2 a....	19/9
250-0-250 v. 100 mA., 6.3 v. 4 a., 0-5-6.3 v., 3 a...	27/9
300-0-300 v. 100 mA., 6.3 v. 4 a., 0-5-6.3 v. 3 a....	27/9
300-0-300 v. 130 mA., 6.3 v. 4 a., 0-5-6.3 v. 1 a., suitable for Mullard 510 Amplifier.....	33/9
350-0-350 v. 100 mA., 6.3 v. 4 a., 0-5-6.3 v. 3 a....	27/9
350-0-350 v. 150 mA., 6.3 v. 4 a., 0-5-6.3 v. 3 a....	35/9

MIDGET CLAMPED TYPE. Primaries 200-250 v.

250-0-250 v. 60 mA., 6.3 v. 2 a., 2μ×2μ×2½in.....	12/9
250 v. 60 mA., 6.3 v. 2 a. Size 2μ×2μ×2½in.....	11/9

FILAMENT TRANSFORMERS 12 v. 1 a..... **7/9**

6.3 v. 1.5 a..... **5/9**	6.3 v. 3 a. **8/11**
6.3 v. 2 a. **7/6**	6.3 v. 6 a. **17/9**
	12 v. 3 a. or 24 v. 1.5 a **17/9**

AUTO (Step Up/Step Down) TRANSFORMERS

50-80 watts 110-120 v./230-250 v.	13/9
150 watts 110-120 v./200-250 v.	27/9
250 watts 110-120 v./200-250 v.	39/9

OUTPUT TRANSFORMERS

Midget Battery Pentode 66.1 for 3S4, etc.	4/6
Small Pentode 5,000Ω to 3Ω	4/6
Standard Pentode 5,000Ω to 3Ω	5/9
Standard Pentode 7,000Ω to 3Ω	5/9
Push pull 8 watts EL84 to 3Ω	8/9
Push pull 8 watts EL84 to 15Ω	8/9
Push pull 10-12 watts 6V6 to 3Ω or 15Ω	16/9
Push pull 10-12 watts to match 6V6 to 3-5-8 or 15	17/9
Push pull EL84 to 3 or 15Ω 10-12 watts	17/9
Push pull Ultra Linear for Mullard 510, etc.....	29/6
Push pull 15-18 watts, sectionally wound 6L6, KT66, etc., for 3 or 15Ω	29/9
Push pull 20 watt high-quality sectionally wound, EL34, 6L6, KT66, etc., to 3 or 15Ω fully shrouded	47/9

MICROPHONE TRANSFORMERS

120-1 High quality, clamped.....	8/9

SMOOTHING CHOKES

250 mA., 5 H., 100Ω **11/9**	80 mA., 10 H., 350Ω **5/6**
150 mA., 7-10H,250Ω **11/9**	60 mA., 10 H., 400Ω **4/11**
100 mA., 10 H., 200Ω **8/9**	1 amp. 0.5Ω L.T. type **6/6**

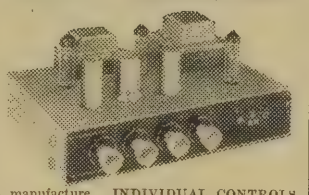
AUDIOTRINE HIGH FIDELITY SPEAKER SYSTEMS

Designed to provide a smooth frequency response from 40-20,000 c.p.s. consisting of 12in. 12,000 line 15 ohm speaker. Crossover Unit and Tweeter. Highly recommended for use with any High Fidelity Amplifier. 10 Watt Unit **£4/19/6** or Deposit **11/3** and nine monthly payments of **11/3.** 20 Watt Unit **£6/19/9** or Deposit **15/9** and nine monthly payments of **15/9.**

GL3A MINIATURE 3-WATT GRAM. AMPLIFIERS. For 200-250 v. 50 c.p.s. A.C. mains. Overall size only 11½ × 2½ × 2½in. Fitted Vol. and Tone Control with mains switch. Designed for use with any kind of single player or record changer unit. Output for 2-3 ohm speaker. Only **59/6.**

R.S.C. A11 12-14 WATT AMPLIFIER

HIGH FIDELITY PUSH-PULL ULTRA LINEAR OUTPUT "BUILT-IN" PRE-AMP STAGES



Two input sockets with associated controls allow mixing of "mike" and gram. as in A.10 High sensitivity. Includes 5 valves ECC83, ECC83, EL84, EL84, EZ81. High Quality sectionally wound output transformer specially designed for Ultra Linear operation and reliable small condensers of current manufacture. INDIVIDUAL CONTROLS FOR BASS AND TREBLE "Lift" and "Cut." Frequency response ± 3 D.B. 30-30,000 c/s. Six negative feedback loops. Hum-level 60 D.B. down. ONLY 23 millivolt INPUT required for FULL OUTPUT. Suitable for use with all makes and types of pick-ups and microphones. Comparable with the very best designs.

For **STANDARD or LONG PLAYING RECORDS.** For **MUSICAL INSTRUMENTS** such as **STRING BASS, GUITARS, etc. OUTPUT SOCKET** with plug provides 300 v. 30 mA. and 6.3 v. 1.5 a. For supply of a **RADO FEEDER UNIT.** Size approx. 12×9×7in. For A.C. mains 200-250 v. 50 c/s. Output for 3 and 15 ohms speakers. Kit is complete to last nut. Chassis is fully punched. Full instructions and point-to-point wiring. **8 Gns.** Carr. diagrams supplied (or factory built **51/6** extra) ONLY 10/-. If required louvred metal covers with 2 carrying handles can be supplied for **18/9. TERMS ON ASSEMBLED UNITS. DEPOSIT 24/9** and **9** monthly payments of **24/9.** Send S.A.E. for illustrated leaflet of Cabinets, Speakers, "Mikes" etc. Cash or Terms.

R.S.C. BASS-MAJOR 30 WATT GUITAR AMPLIFIER

A Multi-Purpose High Fidelity, High Output Unit for Vocal and instrumentalist Groups. Incorporating two 12in. heavy duty 25-watt high flux (17,000 lines) loudspeakers with 2in. diameter pole pieces (total flux 220,000 lines). Designed for efficiently handling more than full output of amplifier at frequencies down to 25 c.p.s. One speaker has an aluminium speech coil and dual cone to extend frequency up to 17,000 c.p.s.

Heavily made cabinet of convenient size 24×21×14in. has an exceptionally attractive covering in two contrasting tones of Vynair. For 200-350 v. 50 c.p.s. A.C. mains operation. EMINENTLY SUITABLE FOR BASS, LEAD or RHYTHM GUITAR AND ALL OTHER MUSICAL INSTRUMENTS. Four jack socket inputs and two independent vol. controls for simultaneous connection of up to four instrument pick-ups or microphones.

Separate bass and treble controls providing more than adequate "Boost" or "Cut" Level frequency response throughout the audible range.

39½ Gns. Carr. 17/6. Or DEPOSIT **£4/3/-** and 12 monthly payments of **£3/9/11.**

Superior to units at twice the cost. Send S.A.E. for illustrated leaflet.

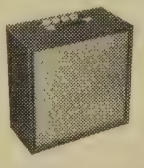
G.5. GUITAR AMPLIFIER

5-watt high quality output. Incorporating high flux 12in. 10 watt, 12,000 line loudspeaker. Sensitivity 30 m.v. High impedance jack input. Handsome strongly made cabinet (size 14×14×7in. approx.) finished in contrasting shades of Rexine and Vynair. 200-250 A.C. mains operation. **£9/19/6** Carr. 7/6 Send S.A.E. for leaflet. Or DEPOSIT **22/3** and nine monthly payments of **22/3.**

R.S.C. BASS-20 GUITAR AMPLIFIER. With 15in. 30 watt heavy duty speaker. Robust Rexine covered cabinet. **Only 29½ Gns.** Send S.A.E. for leaflet.

LINEAR TREMOLO/PRE-AMP. UNIT Designed for introducing the Tremolo effect to any amplifier fitted with a reserve power supply point for smoothed H.T. and 6.3 v. A.C. This applies to practically all amplifiers of our manufacture and to those of several other manufacturers. The unit plugs into power supply point and any input socket or amplifier. Controls are Speed (frequency of interruptions). Depth (for heavy or light effect). Volume, and Switch Three sockets are for 2 inputs and Foot Switch. Only **4 Gns.**

MICROPHONES. Full range from 14/9. Also Desk & Floor Stands

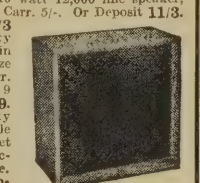


R.S.C. SENIOR 15 WATT LEAD OR RHYTHM GUITAR AMPLIFIER. High-fidelity push-pull output. Separate bass and treble "cut" and "boost" controls. Twin separately controlled inputs so that two instruments or "mike" and pick-up can be used at the same time. A heavy duty 20 watt high flux 12in. loudspeaker with cast chassis is used. Cabinet is well made and finished as Junior Model. Size approx. 18×18×8in. **19 Gns.** or DEPOSIT **39/11** and 12 monthly payments **33/4.** Carr. 10/-. Send S.A.E. for leaflet.

LOUDSPEAKERS IN CABINETS

12in. 10 WATT. Walnut Veneered Cabinet size 15×15×8in. approx. High quality 12in. 10 watt 12,000 line speaker, 3 ohms or 15 ohms **£4/19/6.** Carr. 5/-. Or Deposit **11/3.** and nine monthly payments **11/3**

12in. 20 WATT. High Quality 15,000 line l/speaker 15 ohms in Cabinet finished as above. Size 18×18×8in. **£7/19/6.** Carr. 7/9 or Deposit **17/9** and 9 monthly payments of **17/9.**



15in. 30 WATT. Heavy Duty High Flux Speaker. Suitable for BASS GUITAR. Cabinet 24×21×15in. Heavy contruction covered in attractive. Rexine and Vynair in two contrasting tones of grey. Only **19½ GNS.** Or Deposit **37/6** and 12 monthly payments **37/6.** Full range of cabinets stocked.

R.S.C. STANDARD BASS REFLEX CABINET. For 12in. Loudspeakers, acoustically lined and ported. Size 20in. × 14 × 13in. Beautiful walnut veneer finish. Especially recommended for use with Speaker system below. **£5/19/6.** Set of four legs can be supplied with braes ferrules for **19/6.**

AUDIOTRINE CORNER CONSOLE CABINETS. Strongly made. Beautiful polished walnut veneered finish. Pleasing design.

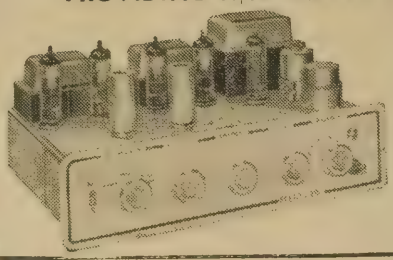
JUNIOR MODEL. To take up to 8in. speaker. Size approx. 20 × 11×8in. Only **49/9.**

STANDARD MODEL. To take up to 10in speaker. Size 27 × 18×12in. **£4/11/9.**

SENIOR MODELS. To take up to 12in. speaker and with Tweeter cut-out. Size approx. 30×30× 15in. (Recommended for use with Audiotrine speaker system). **7 Gns.** or terms.

INTRODUCING THE R.S.C. STEREO/20 HIGH FIDELITY AMPLIFIER

PROVIDING 10/14 WATTS ULTRA LINEAR PUSH-PULL OUTPUT ON EACH CHANNEL



Facilities include:

★ **Three-position tone compensation switch.**

★ **Stereo/Mono switch so that peak monaural output of 28 watts can be obtained.**

★ **Separate Bass "lift" and "cut" and treble "lift" and "cut" controls.**

★ **Neon panel indicator.**

SUITABLE for "MIKE," GRAM, RADIO OR TAPE. INTENDED FOR THE HOME OR STUDIO BUT EQUALLY SUITABLE FOR LARGE HALLS OR CLUBS.

For operation on standard 200-250 v. A.C. mains.

12 gns. Carr. 10/-. Complete set of parts with point to point wiring diagrams and instructions, or Factory assembled, tested and supplied with our usual 12 months' guarantee for **16** gns. or DEPOSIT **37/9** and nine monthly payments of **37/9**. Protective wooden cabinet covered in pleasing shade of leathercloth and fitted carrying handles and plastic feet **59/9** extra or DEPOSIT **6/9** and nine monthly payments of **6/9**.

Based on a current Mullard design and employing valves ECC83, ECC83, ECL86, ECL86, ECL86, ECL86, EZ81. Output transformers are high quality sectionally wound to required specification. Output matchings for 3 and 15 ohm speakers on each channel.

FREQUENCY RESPONSE + 2dB. 30-20,000 c.p.s. Hum level 65dB down.

SENSITIVITY: 15 millivolts maximum. Send S.A.E. for illustrated leaflet.

R.S.C. COLUMN SPEAKERS

Cabinets polished walnut veneer finish, or two tone Rexine/Vynair. Ideal units for vocalists and public address systems.

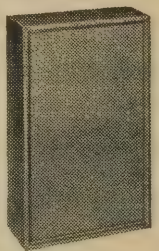
Type C58 20 watts for 15 ohms and 100v. line. Fitted five 8in. high flux P.M. Speakers and matching transformers. **15 gns.** Carr.10/-.

Size approx. 48in. × 10in. × 5in. Or Deposit **34/9** and nine monthly payments of **34/9**.

Type C57 as above model but 15 watts rating and incorporating five elliptical speakers with an overall size of approx. 26in. × 9in. × 4in. **11 gns.** Carr. 7/6. Or Deposit **25/9** and nine monthly payments **25/9**.

FANE EXTRA HEAVY L/SPEAKER 183. 18in., 15 ohms. 60 watts, 3in. diam. Speech Coil. Total Flux 375,000 lines. High sensitivity. ONLY **24** gns. or Deposit **51/-** and 12 monthly payments of **42/9**. Send S.A.E. for leaflet on 153 and 183.

THE AUDIOTRINE 3D/1



A complete three diaphragm high fidelity loudspeaker unit designed to occupy a minimum or space. Depth is only approx. 6in. Height 24in. Width 15in. This has been made possible by the latest developments in loudspeaker design. The 12in. cast chassis Bass unit has a resonant frequency which is extraordinarily low. It has a second diaphragm which extends the frequency range to 17,000 c.p.s. A further speaker operates only on the middle frequencies and ensures a smooth response from 40-17,000 c.p.s. Rating 20 watts. Imp. 15 ohms. Cabinet finish is either polished walnut veneer, or leathercloth to match stereo/20 cabinet. Highly recommended for any Stereo or Mono amplifier. Surely the best value ever at **11 gns.** Or Deposit **25/9** and nine monthly payments of **25/9**.

FANE EXTRA HEAVY DUTY LOUDSPEAKER 15in. TYPE 153. 40 watts. Total flux 375,000 lines. Extremely high sensitivity. 15 ohm voice coil. Only **18 gns.** or Deposit **37/9** and 12 monthly payments of **31/6**.

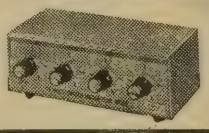
AUDIOTRINE EQUIPMENT CABINETS

Size 36 × 15 × 18in. Beautiful walnut veneered finish. Elegant contemporary design. Robust construction. Uncut removable baseboard. Depth above baseboard 5½in. Only **12½ gns.** Carr. 15/-. Terms: Dep. **29/9**, and 9 mthly. pymts. **29/9**.

R.S.C. JUNIOR HI-FI REPRODUCER.

The very latest Goodmans Axiette 8 High Fidelity loudspeaker (retailing at £5/17/7) fitted in a specially designed Bass Reflex cabinet size 12in. × 18in. × 10in. Acoustically lined and ported and finished in polished walnut veneer. Matching impedance 15 ohms. Frequency range 40-15,000 c.p.s. Power handling 6 watts nominal. Ideal for Stereo. Limited number at ONLY **8 gns.** Carr. 4/6.

TRANSISTORISED MICROPHONE MIXER



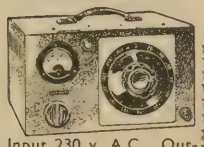
Enables mixing of up to 4 instruments, i.e. mic, tape, gram, tunes, etc., into single output. Compact and completely self-contained, uses standard 9 v. battery. Inputs and outputs take standard plugs. PRICE **49/6**

R.S.C. BRADFORD, BRISTOL, BIRMINGHAM, DERBY, DARLINGTON, EDINBURGH, GLASGOW, HULL, LEICESTER, LEEDS, LIVERPOOL, LONDON, MANCHESTER, MIDDLESBROUGH, SHEFFIELD

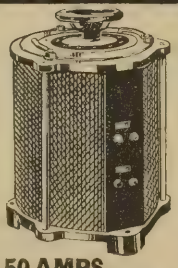
PAGE 106 FOR ADDRESSES

WE ARE ENGLAND'S LARGEST IMPORTERS OF VARIABLE VOLTAGE TRANSFORMERS

PORTABLE



Input 230 v. A.C. Output variable 0-260 v. A.C. at 2.5 a. Fitted in beautifully finished steel case. Complete with volt meter, pilot lamp, fuse, switch, carrying handle, **£9/17/6.**



50 AMPS.

1 AMP.

INPUT 230 v. A.C. 50/60~

BRAND NEW. Carriage Paid. Buy direct from the importer, keenest prices in the country. All Types (and Spares) from 1 to 50 amp. available from stock.

We are pleased to announce further additions to our range:

0-260 v. at 1 amp.	£4 10 0
0-260 v. at 2.5 amps. ...	£5 17 6
2.5 amps., Portable.....	£9 17 6
0-260 v. at 5 amps.	£9 0 0
0-260 v. at 8 amps.	£14 10 0
0-260 v. at 10 amps.	£16 10 0
0-260 v. at 12 amps. ...	£18 15 0
0-260 v. at 20 amps. ...	£32 10 0
0-260 v. at 37.5 amps. ...	£65 0 0
0-260 v. at 50 amps.	£85 0 0

These instruments are fully shrouded.

INSULATED TERMINALS available in black, red, white, yellow, blue and green. New **15/-** per doz. P. & P. 1/-.

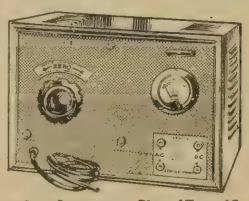
SPECIAL REVERSING 24 VOLT D.C. MOTOR 2 AMPERE.

Quadrant moves 90 degrees with limit switches. Ideal for opening doors, etc. Price **32/6.** P. & P. 3/-.

1 AMP. OPEN TYPE

(Type IA.) Compact, well constructed unit designed for building into equipment. Panel or back mounting, extending shaft. Complete with engraved voltage panel and control knob. Input 230 v. A.C. Output variable 0-260 v. Ideally suited for Manufacturers of variable voltage equipment. Price **£4/17/6** post paid.

VARIABLE OUTPUT UNIT



7 amps. A.C./D.C. Input 230 v. A.C. Output continuously VARIABLE from 0 to 260 v. A.C. OR 0 to 230 v. D.C. at 7 a. Robustly constructed in metal case, complete with safety fuse, neon indicator and voltmeter. Size 17 x 12 x 7in. Weight 36lb. Price **£34/10/-.** Carriage 20/-.

SLIDER RESISTANCES

Geared drive, new. 1.2 ohm, 14 amp. **27/6**; 75 ohm, 2 amp. **37/6**; 200 ohm, 1.25 amp. **37/6**; 36 ohm, 6.5 to 2.8 amp., tapered winding, geared drive (less knob). **37/6.** P. & P. 3/6.

INSULATION TESTERS (NEW)

Test to I.E.E. Spec. Rugged metal construction, suitable for bench or field work, constant speed clutch. Size L, 8in., W, 4in., H, 6in. Weight 6lb. 500 volt, 500 megohms. Price **£22,** carriage paid. 1,000 volts, 1,000 megohms, **£28,** carriage paid.

SERVICE TRADING COMPANY

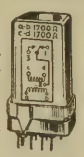
SERVICE TRADING CO

Postage and Carriage shown below are inland only. For overseas please ask for quotation. We do not issue a catalogue or list.

ULTRA VIOLET BULBS

Easy to use source of UV for dozens of practical and experimental uses.
12 volt 36 watt AC/DC SBC **6/6.** P. & P. 1/-.
12 volt 60 watt AC/DC SBC **8/6.** P. & P. 1/-.
Transformer to suit the above, Input 200-240 A.C. 12 volt 36 watt, **16/6**; P. & P. 2/6. Input 200-240 A.C. 12 volt 60 watt, **22/6.** P. & P. 3/6.
Set of 4 Colours FLUORESCENT PAINT. Red, yellow, green and cerise. In ½oz. tins. Ideal for use with the above Ultra Violet Bulbs. **9/6,** plus 1/6 P. & P.

SIEMENS SEALED HIGH SPEED RELAYS



H96A, 2.2 ohm + 2.2 ohm, new **12/6.**
H96B, 50 ohm + 50 ohm, new **12/6.**
H96C, 145 ohm + 145 ohm, new, **12/6.**
H96D, 500 ohm + 500 ohm, new **12/6.**
H96F, 1000+1000 ohm, new **12/6.**
H96E, 1700 ohm + 1700 ohm, ex-equip., **16/6.** P. & P. 1/- on each Relay.

CARPENTER'S POLARISED RELAY. Type 5A13 (2), 2 × 7,600 turns at 1,000 Ohms, New, 22/6 p. & p. 1/-.
Type 5A57, 65 ohm. coil will operate on less than .5 of a volt. **22/6.** P. & P. 1/-.
Bases For Carpenter Relay, New, 3/6 each.

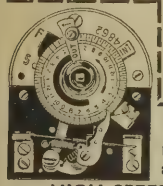
P.O. RELAYS, Type 3,000
200 ohm., 6 c/o 6,500 ohm., 1 c/o 1 break.
500 ohm., 6 c/o 16,000 ohm., 2 make 2 break.
500 ohm., 4 Heavy Duty Make.
2,000 ohm., 4 make 4 break.
All at **12/6** each, plus 1/- P. & P. each.

G.E.C. SEALED RELAYS
M1069 5000 ohm. 2 c/o. M1084 180 ohm. 4 c/o. M1092 670 ohm. 4 c/o. M1095 670 ohm. 2 m. 2 b. M1100 670 ohm. 2 c/o. Ex new equipment. All at **12/6** each plus 1/- P. & P.

7,000 OHM SEALED RELAY. High Speed single c/o Platinum contacts. Super-sensitive, ideal for Transistor circuitry. Will operate on 1 milliamp. **25/-.** P. & P. 1/-.

Latest type **SIEMENS MINIATURE RELAY** in Transparent Case. 4 c/o 700 ohm coil. 24 V. D.C. operation. Size 1⅜ × ⅝ × 1⅛in. Ex new equipment unused. Price **12/6** inclusive postage.

EVERSHED AND VIGNOLES BRIDGE MEGGER. 500 v. Constant Pressure Series 2 with decade and varley loop facilities, perfect condition, **£40** including leather case and carriage.
NSP2 CV2296 STROBOTRON FLASH TUBE made by Ferranti, brand new, I.O. base. Price **15/-.** P. & P. 1/-.
EVERSHED AND VIGNOLES MEGGER CIRCUIT TESTER. (Low reading ohm meter.) 2 ranges, 0-3, 0-30 ohms. Complete with test leads, battery and leather carrying case. **£6/6/-.** Post paid.



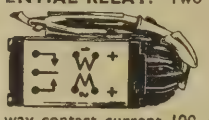
RESETTABLE HIGH SPEED COUNTER. 3 figure, 1,500 ohm coil, 40-50 v. D.C. operation. Brand new. **50/-** each plus 1/6 P. & P.

14-DAY CLOCK-WORK TIME SWITCHES USED but guaranteed 5 amp. type, **35/6.** P. & P. 2/6.

HIGH SPEED BLOWER UNIT 200/250 volt A.C. Powerful 2-speed motor, 11,000 and 13,000 R.P.M. **17/6,** plus 2/6 P. & P.
EX P.O. MAGNETIC COUNTER (old type), either 500 ohms for 24 volt operation or 3 ohms for 6 volt D.C. operation. 4 figures to 9,999. Price, either type **8/6.** P. & P. 1/6.
LATEST HIGH SPEED MAGNETIC COUNTERS, 4 figure, 10 impulses per second. Type 100D, 4.1 ohm coil, 3-6V. D.C. operation. Type 100A, 500 ohm coil, 18-24V. D.C. operation. Type 100B, 2,300 ohm coil, 36-48V. D.C. operation. Any type **15/-** each, plus 1/6 P. & P.
DIALS FOR AUTOMATIC TELEPHONES used but good condition, **12/6** ea, plus 2/6 P. & P.

CROMPTON PARKINSON BRAND NEW ¼ h.p. MOTORS. 230/250 VOLT A.C. 1,400 R.P.M. Fitted with 2½ × ½in. SPINDLE. **Price £3/15/-.** Carriage 8/6.

6-VOLT 40 A.H. ACCUMULATORS in metal case with leather carrying handle. Brand new, **27/6.** Carriage 8/-.
AUTO TRANSFORMERS. Step up, step down. 110-200-220-240 v. Fully shrouded. New. 300 watt type **£2/6/6** each. P. & P. 2/6. 500 watt type **£3/7/6** each. P. & P. 3/9. 1,000 watt type **£4/10/-** each. P. & P. 6/6.
MINIATURE MOVING COIL DIFFERENTIAL RELAY. Two coils 350 ohms each.



Operating current minimum 140 microamp., nominal 400 microamp, maximum 8 milliamp. One pole two way, or centre stable. Two way contact current 100 mA. at 50 v. A.C. or D.C. Size 1¼ × ⅜ × ⅜in. Individually tested. Price **22/6** each, 1/-. P. & P.

230 v. A.C. RELAY, 10,000 ohm coil, 3 changeover, 5 amp. non inductive load, price **18/6,** plus 1/6 P. & P.

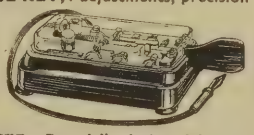
230 VOLT A.C. GEARED MOTORS
Type B16G 80 r.p.m. .26lb. inch £1/19/6. P. & P. 2/-.
Type D16G 5 r.p.m. 1.7lb. inch £2/9/6. P. & P. 2/6.
Type D16G 13 r.p.m. 1.45lb. inch £2/12/6. P. & P. 2/6.

230 Volt AC 50 c/s 5-figure Veeder-root Counter (not resettable). New. Boxed. **19/6,** plus 2/6 P. & P.

MINIATURE UNISELECTOR SWITCH
3 banks of 11 positions, plus homing bank. 40 ohm coil. 24-36 v. operation. Ex equip. Individually tested. **22/6,** plus 2/6 P. & P.
20-way STRIP containing standard Post Office telephone Jack Sockets, overall size 11 × 3½in. × ½in. New. Price **15/-** each. P. & P. 1/6.

LIGHT SENSITIVE SWITCH
Kit and parts including ORP.12 Cadmium Sulphide Photocell, Relay, Transistor and Circuit. Now supplied with new Siemens High Speed Relay for 6 or 12 volt operation. **Price 25/-,** plus 2/6 P. & P.
ORP.12 and Circuit 10/6, post paid.

SEMI-AUTOMATIC "BUG" SUPER SPEED MORSE KEY, 7 adjustments, precision tooled, speed adjustable, 10 w.p.m. to as high as desired. Weight 2½ lb. Price **£4/12/6,** post paid.



KEYING LEVER. Especially designed for use with all types of electronic keyers. Fully adjustable micro-switch action, no contact bounce, precision made, finely polished parts, screw down base. Price **£4/4/-,** post paid.
TRANSISTORISED FULLY AUTOMATIC ELECTRONIC KEYER. 230V. A.C. or Battery operated. Incorporates built-in monitor Oscillator, Speaker, and Keying Lever. Adjustable speeds. Keying either auto., semi-auto. or hold. 4 diodes. 7 transistors. Price **£16/10/-** Plus 4/6 P. & P.

80 AMP FOSTER CONSTANT VOLTAGE TRANSFORMER. Automatic or hand operated. Input 250 v. + 5—15%. Output adjustable 200/250 v. Limited number of these units available requiring slight attention to bring up to new condition. **Price £65** each, ex-warehouse.
SOLENOID. Overall length 3½in., stroke ⅛in. to ¼in. Maximum push 8 oz. 12-24V. D.C. operation. D.C. resistance 35 ohm. Price **8/6.** P. & P 1/6.

TRANSISTORS — 1st grade / Brand new

OC29	18/-	OC203	14/-
OC41	7/-	Get 104	6/-
OC45*	5/-	Get 105	10/-
OC71	5/-	Get 573*	12/6
OC72*	7/-	2G110	17/6
OC73	6/-	2N458	20/-
OC75	7/-	2S019	30/-
OC76	6/-	SB345	7/6
OC81*	8/-	TK208	4/-
OC84*	10/6	AC107	14/6
OC139	12/-	AF114	11/-
OC140	19/-	AF115	10/6
OC171	10/6	AF116	10/-
OC201	21/-	AF117	9/6
		BCZ11	10/-

*Available in Matched Pairs.

DIODES

OA91	3/-	1S111	4/-
SX781	4/-	ZS10B	3/-

ZENERS 5%
All ¼ watt 5% at **10/-** each, 4.3 v., 4.7 v., 5.1 v., 5.6 v., 6.2 v., 6.8 v., 7.5 v., 8.2 v., 9.1 v., 10 v., 12 v., 15 v., 16 v., 22 v.

HEAVY DUTY L.T. TRANSFORMER
Very conservatively rated for continuous duty. Input 110-260 volts, multi tapped, 50 cycles, single phase. Output 28,29,30,31 volts at 21 amp. Price **£6/15/-.** Carr. 10/-.

L.T. TRANSFORMER
Type 1. Pri. 200-240 sec. tapped 30, 32, 34, 36 volt at 5 amp., **57/6.** P. & P. 4/-.
Type 2. Pri. 240 sec. tapped 30, 40 and 50 volt at 5 amp., **£4/15/-.** P. & P. 4/-.
Type 3. Pri. 200-240 sec. tapped 10, 17 and 18 volt at 10 amp., **57/6.** P. & P. 4/-.
Type 4. Pri. 240 sec. tapped 6 and 12 volt at 20 amp., **72/6.** P. & P. 5/-.

A.C. AMMETERS
0-1, 0-5, 0-10, 0-15, 0-20 amp. F.R. 2½in. dia. All at **21/-** each

A.C. VOLTMETERS

0-15 V. A.C. M.I. 2½in. F.L.	12/6
0-200V. A.C. Rect M-Coil 3½in. Type W23	45/-
0-300V. A.C. M.I. 2½in. F.L.	22/6
0-300V. A.C. Rect. M-Coil 2½in.	29/-
0-300V. A.C. Rect. M-Coil 3½in. Type W23	55/-

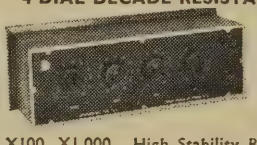
D.C. AMMETERS

0-15 amp. D.C M-Coil 2" Rnd.	12/6
0-5 amp. D.C. M.I. 2½" Rnd.	11/6
0-500 Microamp sub-min. 1½" dia. Scaled 0-1 milliamp.	21/-

Postage extra.

W.W. RHEOSTAT. 22 ohm 1.5 amp., complete with knob, 8/6 plus 1/6 P. & P.
OIL-FILLED CONDENSER. 240 mfd. for 230 V.A.C. or 600 volt D.C. Overall size 14in. x 9in. x 5½in. plus feet. Weight 46 lb. Brand new. Guaranteed perfect. Manufacturer's packing. Price **£7/10/-.** Carriage 10/-.
VAN DE GRAAFF ELECTRO-STATIC GENERATOR, fitted with motor drive for 230 v. A.C. giving a potential of approx. 50,000 volts. Supplied absolutely complete, including accessories for carrying out a number of interesting experiments, and full instructions. This instrument is completely safe, and ideally suited for School demonstrations. Price **£6/6/-** plus 4/- P. & P. *Leaflet on request.*

4 DIAL DECADE RESISTANCE BOX



Range 0-11,110 ohm. X1 Wire Wound, Max. current 300 mA. X10 Wire Wound, Max. current 150 mA.
X100, X1,000. High Stability Resistors, rated 1 watt. Accuracy + —1%.
Switches, make before break type, fitted with low resistance silver plated contacts, polished wood case, new, price **£10/10/-,** plus 6/6 P. & P.
BUILD AN EFFICIENT STROBE UNIT FOR ONLY "37/6"
The ideal instrument for workshop, lab. or factory. This wonderful device enables you to "freeze" motion and examine moving parts as if stationary. We supply a simple circuit diagram and all electrical parts, including the NSP2 Strobe tube which will enable you to easily and quickly construct a unit for infinite variety of speeds, from 1 flash in several seconds to several thousands per minute. New, modified circuits bring price down to **37/6,** plus 3/- P. & P.

ALL MAIL ORDERS. ALSO CALLERS AT:
47-49 HIGH STREET, KINGSTON-ON-THAMES.
Telephone: KINgston 9450.
Closed Saturdays.

PERSONAL CALLERS ONLY: **9 LITTLE NEWPORT STREET, LONDON, W.C.2.** *Tel.: GER 0576.*
(OFF LEICESTER SQUARE).
Open till 1 p.m. Thursday and all day Saturday.

Why NOT BUILD ONE OF OUR PORTABLE TRANSISTOR RADIOS . . .

BACKED BY OUR SUPER AFTER SALES SERVICE

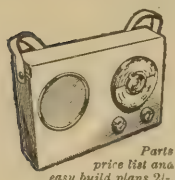
POCKET FIVE

★ 7 Stages—5 transistors and 2 diodes. Covers Medium and Long Waves and Trawler Band, a feature usually found in only the most expensive radios. On test, Home, Light, Luxembourg and many Continental stations were received loud and clear. Designed round supersensitive Ferrite Rod Aerial and fine tone 2½in. moving coil speaker, built into attractive black case with red speaker grille. Size 5½ × 1½ × 3½in. (Uses 1289 battery, available anywhere.)

Total cost of all parts now only **42/6** P. & P. 3/-.

Parts price list and easy build plans 1/6.

ROAMER SIX *NEW!!*



★ 8 stages—6 transistors and 2 diodes. ★ 6 waveband. ★ Now with Philco micro-alloy R.F. transistors.

Listen to stations half a world away with this 6 waveband portable. Tunable on Medium and Long waves, Trawler Band and three Short waves. Sensitive ferrite rod aerial and telescopic aerial for short waves. Top grade transistors, 3-inch speaker, handsome case with gilt fittings. Size 7½ × 5½ × 1½in. ★ Extra band for easier tuning of LUX. etc.

Total cost of all parts now only **£3.19.6** P. & P. 3/6.

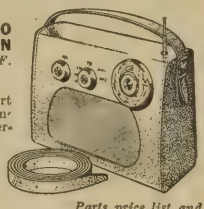
Carrying Strap 2/- extra.

Parts price list and easy build plans 2/-.

ROAMER SEVEN Mk. III

5 WAVEBAND PORTABLE OR CAR RADIO AMAZING PERFORMANCE AND SPECIFICATION

★ *NOW WITH PHILCO MICRO-ALLOY R.F. TRANSISTORS.*



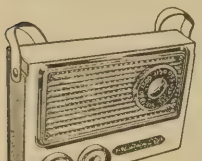
★ 9 stages—7 transistors and 2 diodes.

Covers M. and L. Waves, Trawler Band and two Short Waves to approx. 15 metres. Push-pull output for room-filling volume from rich toned heavy duty 5in. speaker. Air spaced ganged tuning condenser. Ferrite rod aerial for M. & L. Waves and telescopic aerial for S. Waves. Real leather look case with gilt trim and shoulder and hand straps. Size 9 × 7 × 4in. approx. The perfect portable and the ideal car radio. (Uses PP7 battery available anywhere.)

Total cost of all parts NOW ONLY **£5.19.6** P. & P. 5/6.

Parts price list and easy build plans 3/-

SUPER SEVEN



★ 9 Stages—7 transistors and 2 diodes.

Covers M. and L. Waves and Trawler Bands. The ideal radio for home, car or can be fitted with carrying strap for outdoor use. Completely portable—built-in ferrite rod aerial for wonderful reception. Special circuit incorporating 2 RF stages, push-pull output, 3in. speaker (will drive larger speaker). Size 7½ × 5½ × 1½in. (Uses 9v. battery, available anywhere.)

Total cost of all parts now only **£3.19.6**

Parts price list and easy build plans 2/-. P. & P. 3/6.

NEW!! TRANSONA SIX

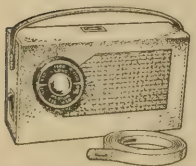
★ 8 stages—6 transistors and 2 diodes.

A top performance receiver covering full M. & L. Waves and Trawler Bands. High-grade approx. 3in. speaker makes listening a pleasure. Push-pull transformers for ample power. Ferrite rod aerial. Many stations listed in one evening including Luxembourg loud and clear. Attractive case in grey with red grille. Size 6½ × 4½ × 1½in. (Uses PP4 battery, available anywhere.)

Total cost of all parts **59/6** P. & P. 3/6.

Parts price list and easy build plans 2/-.

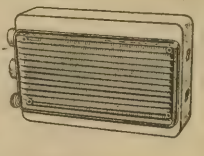
MELODY SIX *NEW!!*



★ 8 stages—6 transistors and 2 diodes. Our latest completely portable transistor radio covering M. and L. waves. Incorporates pre-tagged circuit board, 3in. heavy duty speaker, top grade transistors, volume control, tuning condenser, wave change slide switch, sensitive 6in. ferrite rod aerial, Push-pull output. Wonderful reception of B.B.C. Home and Light, 208, and many Continental stations. Handsome leather look pocket size case, only 6¾ × 3¼ × 1½in. approx. with gilt speaker grille and hand and shoulder straps.

Parts price list and easy build plans 2/-. Total cost of all parts **£3.9.6** P. & P. 3/-.

TRANSONA FIVE



★ 7 Stages—5 transistors and 2 diodes.

Covers M. and L. Waves and Trawler Bands, a featur usually found in only the most expensive radios. On test, Home, Light, 208, and many Continental stations were received loud and clear. Designed round supersensitive Ferrite Rod Aerial and new type fine tone super dynamic 2½in. speaker, attractive case in grey plastic with red grille. Size 6½ × 4½ × 1½in. approx. (Uses 1289 battery available anywhere)

Total cost of all parts. NOW ONLY **42/6** P. & P. 3/6.

Parts price list and easy build plans 2/-.

All components used in our receivers may be purchased separately if desired. Parts price lists and easy build plans supplied free with sets of parts or available separately at prices stated. *OVERSEAS POST* 10/-

RADIO EXCHANGE

61, HIGH ST., BEDFORD. Phone: 2367

Callers side entrance Barratts Shoe Shop. *Weekdays 9-5 p.m. Sats. 9-12.30.*

AVO STOCKISTS

MULTIMINOR MK. IV

MODEL 8 MK III

REPAIR SERVICE 7-14 DAYS

We specialise in repair, calibration and conversion of all types of instruments, industrial and precision grade to BSS.89.

Release notes and certificates of accuracy on request.

Suppliers of Elliott, Cambridge and Pye instruments.

LEDON INSTRUMENTS LTD

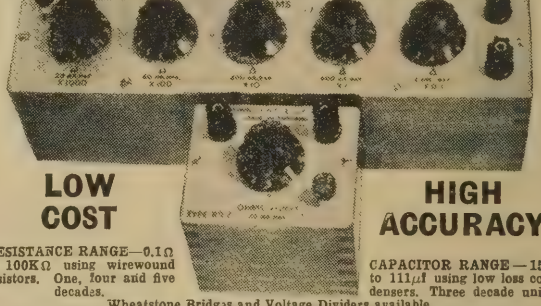
76-78 DEPTFORD HIGH STREET, LONDON, S.E.8.

TEL.: TIDeway 2689

E.I.D. & G.P.O. APPROVED **CONTRACTOR TO H.M. GOVT.**

14WW—137 FOR FURTHER DETAILS.

DECADE RESISTANCE & CAPACITOR BOXES



LOW COST

RESISTANCE RANGE—0.1Ω to 100KΩ using wirewound resistors. One, four and five decades.

HIGH ACCURACY

CAPACITOR RANGE—15pf to 111μf using low loss condensers. Three decade units.

Wheatstone Bridges and Voltage Dividers available.

LIONMOUNT & CO. LTD. 24, Lynton Road, London, N.8.

Tel:—FITzroy 4178

14WW—138 FOR FURTHER DETAILS.

SEMIKRON

Trade only

HIGH, MEDIUM & LOW POWER · AVALANCHE
HIGH TENSION · MINIATURE ENCAPSULATED

SILICON RECTIFIERS

MINIATURE & STACK

SELENIUM RECTIFIERS

Send for full details to sole representative in U.K.

HCD Research Ltd., Laboratories and Works.

77, Gloucester Road, Croydon, Surrey

Telephone : THOrnton Heath 7485

14WW—139 FOR FURTHER DETAILS.

RADIO CLEARANCE LTD.

TRADE ENQUIRIES INVITED

27 TOTTENHAM COURT RD., LONDON, W.1
The oldest Component Specialists in the Trade

Telephone: MUSEUM 9188
EST. 35 YEARS

THE "MINIGRAM"—LIMITED QUANTITY ONLY

DON'T MISS A CHANCE LIKE THIS!

FEATURES:

★ Ready-built amplifier with 4 first grade Mullard transistors
★ Plays 45 r.p.m. Pop records
★ Built-in automatic stop
★ Lightweight and portable
★ Instruction leaflet supplied
★ Crystal pickup with expendable stylus GP59 Type
★ Operates from a 9 v. battery (3/9 extra)
★ Available in two colours, cream/red or cream/blue

A.—Motor and pickup deck, **39/6.** (2/6 P. & P.)
B.—Ready-built 4-Transistor Amplifier complete with Volume Control and Loudspeaker. **35/-.** (2/- P. & P.).
C.—Portable two-tone case with handle, **5/-.** (2/- P. & P.)

Transistorised Record Player

★ Approximate dimension 9 x 8½ x 4in.
★ A real "Family Favourite"
★ Ideal for Teenagers
★ For use ANYWHERE
★ Hours of amusement for the younger members of the family
★ Assemble one of these amazing Players in less than 30 mins., supplied in 3 complete units with only 10 connections to make

ONLY 79/6 *The complete PACKAGE* (Plus 5/- P. & P.)

OR ANY UNIT SOLD SEPARATELY

BARGAINS STILL AVAILABLE IN LOUDSPEAKERS

Enormous purchases of Brand New and guaranteed Plessey loudspeakers enable us to offer these units at **THE LOWEST PRICES EVER.** Don't miss this golden opportunity to obtain a first-grade permanent magnet **LOUDSPEAKER** off the production line at **LESS THAN MANUFACTURER'S COST.** Read carefully the prepared list below and choose just the right speaker for the job—COMPARE THE PRICES ANYWHERE.

SCHEDULE OF LOUDSPEAKERS AVAILABLE

Diameter in inches	Gauss in Lines	Impedance in Ohms	Price	Diameter in inches	Gauss in Lines	Impedance in Ohms	Price	Diameter in inches	Gauss in Lines	Impedance in Ohms	Price
2	7,000	80	8/-	3½	9,500	50	10/6	5	7,500	3	9/-
2½	7,000	35	8/6	4 Twecter	10,000	3	11/6	5	8,500	5	9/6
2½	7,000	50	8/6	4	9,500	15	12/-	5	9,500	3	10/6
2½	7,000	80	8/-	4	7,000	25	11/6	5	9,500	5	10/6
3	8,500	3	10/-	4	6,000	35	10/6	5	9,500	15	12/6
3	6,000	5	8/6	4	7,000	35	11/-	5	9,500	25	10/6
3	7,000	5	9/-	4	9,500	35	11/6	5	8,500	35	11/6
3	7,000	35	9/-	5	6,000	3	8/-	5	9,500	35	11/6
3½	9,500	3	10/6	5	6,000	5	8/-	6½	7,000	3	11/-
3½	9,500	8	10/6	5	7,000	3	8/6	6½	7,000	5	11/-
3½	7,000	35	8/6	5	7,000	5	8/6				

Elliptical Size in ins.	Gauss in Lines	Impedance in Ohms	Price	Elliptical Size in ins.	Gauss in Lines	Impedance in Ohms	Price	Elliptical Size in ins.	Gauss in Lines	Impedance in Ohms	Price
5 × 3	6,000	3	7/6	6 × 4	9,500	35	12/-	8 × 2½	6,000	3	8/6
5 × 3	7,000	3	8/-	7 × 3½	7,000	3	9/6	8 × 2½	7,000	5	9/-
5 × 3	9,000	3	8/6	7 × 3½	9,500	3	10/6	8 × 2½	8,500	5	9/6
5 × 3	9,500	3	9/-	7 × 4	9,500	3	11/-	8 × 2½	9,500	3	10/-
5 × 3	9,000	4	8/6	7 × 4	10,000	3	12/6	8 × 2½	9,500	4	10/-
5 × 3	9,500	15	11/-	7 × 4	10,000	15	13/6	8 × 5	8,500	3	11/-
6 × 4	8,500	3	9/6	7 × 4	9,500	30	12/6	8 × 5	10,000	3	13/-
6 × 4	9,500	3	10/-	7 × 4	9,500	35	12/6				

ALLOW 2/- each speaker for P. & P./handling charges, and please specify the exact requirements—the nearest available will be sent.

YOUR LAST CHANCE TO OBTAIN THIS WONDERFUL SET

Ask for a demonstration in the shop

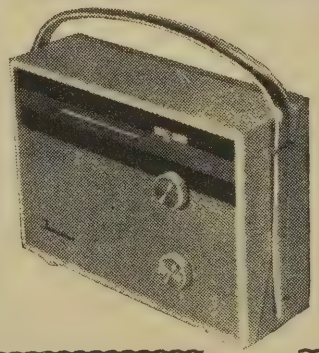
"CAPRI"

Sensitive !
Super-Selective !
Superb Speaker !

NOW ONLY 79/6 (2/- P. & P.)

ONLY OBTAINABLE HERE
Pocket superhet MW and Droitwich.
Size: 4½in. x 2½in. x 1½in.
Constructional data 1/9 Post free.

The best and easiest transistor build-yourself sets available—send S.A.E. for free Parts List.
6 first-grade Mullard Transistors, Diodes, and all components brand new and guaranteed.



CHOICE OF A DOZEN STATIONS IN DAYLIGHT

THE "CONTESSA"

Queen of them all!

TO CLEAR EXISTING STOCKS

£7.19.6

(3/6 P. & P.)
Portable and car radio
2 waveband Superhet.
Constructional Book, 2/10 post free.

Inclusive price for all associated components, case, and instruction book complete in every detail. Any parts SOLD SEPARATELY on the BUILD-AS-YOU-BUY Scheme.

CONTESSA £7/19/6 (plus 3/6 P. & P.). Battery **5/6** extra.
CAPRI 79/6 (plus 2/- P. & P.). Battery **2/6** extra.

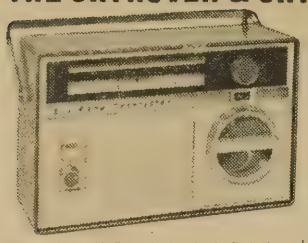
SELECTED BARGAINS

Beautifully geared **AM/FM 2-Gang Condensers 4/6; AM/FM IFT's** 465 kc/s and 10.7 Mc/s. **4/6** pair; Magnavox Crystal Tape Recorder Mikes **12/6; 3** watt Stereo Amplifiers complete ready to switch on, **79/6;** Sentercell rectifiers R3/2D; D3-2-1Y, **2/6** each. **DIODES**—OA70, OA79, OA90, CG46H, GD10, **2/-** each. **TRANSISTORS:** OC45 **4/6;** PXA 101 **3/9;** AF115 **4/6.** SUBMIN **GERMANIUM DIODES 1/3. M.I. DIODES 6d.** each. Silicon Diodes 200 P1V-200 mA. **1/-** each; 400 P1V 330 mA. **2/6** each.

Please send STAMPED AND ADDRESSED envelope with any enquiry. We regret no catalogues—our stocks move too quickly! Kindly make provision for sufficient postage and packing charges to avoid delay. **TERMS:** Cash with order or C.O.D. on orders over 10/-.

THE SKYROVER & SKYROVER De Luxe

ARE NOW AVAILABLE WITH LONG WAVE BAND COVERAGE



A simple additional circuit provides coverage of the 1,100/1,950 M. band (including 1,500 M. Light programme). This is in addition to all existing Medium and Short wavebands. All necessary components with construction data. **Only 10/- extra** Post Free. This conversion is suitable for both models that have already been constructed.

GENERAL SPECIFICATION FOR BOTH MODELS

7-transistor and 2-diode superhet—6 waveband portable receiver, covering the full Medium Waveband (180-576 M.) and Short Waveband (32-94 M.) and in addition 4 separate switched Band Spread Ranges on 13M, 16M, 19M and 25M Bands—with Manual Band Spread Tuning for accurate Station selection. L.F. frequency 470 Kc/s. Output 500 M.W. 5in. Ceramic Magnet P.M. Speaker. Telescopic and internal Ferrite Rod Aerial. All Mullard Transistors and Diodes. The coil pack and tuning heart is completely factory assembled, wired and tested. The remaining assembly can be completed in under three hours from our detailed and easy to follow instructions. Operates on four 1.5 v. torch batteries (U2 or equivalent).

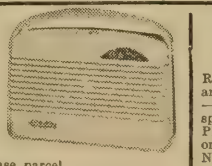
THE SKYROVER. Individual Details—controls: Waveband Selector, Volume Control with on/off switch. Tuning Control with easy to read Dial Scale. In attractive plastic cabinet, size 10 × 6¼ × 3¼in., with metal trim and carrying handle.
MAY NOW BE BUILT FOR £8.19.6
All parts sold separately.
H.P. Terms: 20/- dep. & 11 months at 16/6.

THE SKYROVER DE LUXE. Tone Control Circuit is incorporated with separate Tone Control in addition to Volume and Tuning Controls and Waveband Selector. In sturdy wood cabinet, size 11½ × 6½ × 3in., covered in washable material with plastic trim and carrying handle. Also Car Aerial socket.

MAY NOW BE BUILT FOR £10.19.6 H.P. Terms: 25/- deposit and 11 months at 20/-.
All parts sold separately.

Circuit diagram and data for each set 2/6 extra, free if all parts bought. Four U2 batteries 3/4 extra. **Add 5/- P. & P. on each parcel.**

THE 'REALISTIC 7'



This famous 7-transistor home construction receiver—still available. Full medium and long waveband coverage. 4in. speaker, etc.
MAY BE BUILT FOR £5.19.6 Battery 3/9. P. & P. 4/6.
De luxe version with wood cabinet, full vision dial only £1 extra. All parts available separately. Data and instructions 2/6, refunded if you purchase parcel.

T.V. POWER PACK

Takes a PY32 or 33. Contains: Filament transformer and Smoothing Choke, mains dropping resistor, Brimistor, smoothing capacitor 100—200—16—16 mfd. 275 V/w., 350 V. surge. Also 16—16 mfd. 275 V/w and sundry capacitors, resistors, etc. On metal chassis, size: 6" × 4½" × overall height 5¼". No circuit available.
PRICE 12/6 less rec. valve **23/6** with rec. valve P. & P. 3/6.

BOY'S 2 TRANSISTOR POCKET RADIO

Ready built complete with personal earpiece, battery and carrying case! Wonderful value and performance—full medium waveband coverage—built in 2½in. speaker gives full tone reproduction. Works on single PP3 9 v. battery. In attractive plastic case—size only 4 × 2½ × 1in. All accessories included in the price. Not a toy.
WIRECOMP'S PRICE COMPLETE 42/- POST FREE

6 Transistor pocket radio fully built in plastic case, 4in. × 2½in. × 1in. with 2½in. speaker. Uses single PP3 type battery. Supplied complete with personal earpiece and leather case. Tunable over full medium waveband.
WIRECOMP'S PRICE 69/6 POST FREE

TELEVISION CHASSIS

Made by famous British manufacturer for U.K. use. Switchable time base to 625 line. Brand new and unused, but store soiled. 13 valve plus 2 diode circuit. Designed for 110 electrostatic Cathode Ray Tube—will take 17in., 19in.. 21in. or 23in. tube. Fitted with bands 1/111 turret tuner—complete with 12 sets of coils. All controls fitted. Chassis size: 18in. high × 13in. wide × 5in. deep. Sound output transformer fitted for 3 ohm speaker. For 200/250 v. A.C./D.C. mains operation. **15 GNS.**
WIRECOMP'S PRICE complete with valves and Bands 1/111 Turret Tuner.
P. & P. 12/6 extra.
CAN BE SUPPLIED WITH BRAND NEW 17in. C.R.T. AT INCLUSIVE COST OF 17 GNS.
P. & P. 17/6 extra.

TAPE LAFAYETTE BRAND, FULLY G'TD.

5in.	Double play, 1,200ft. Mylar base....	15/-
5in.	Long Play, 900ft. Acetate base.....	10/-
5in.	Standard play, 600ft. P.V.C. base.....	8/6
5½in.	Long play, 1,200ft. Mylar base.....	15/-
5½in.	Double play, 1,800ft. Mylar base....	22/6
5½in.	Long play, 1,200ft. Acetate base	12/6
5½in.	Standard play, 850ft. P.V.C. base....	11/6
7in.	Standard play, 1,200ft. Mylar base....	12/6
7in.	Long play, 1,800ft. Mylar base.....	19/6
7in.	Double play, 2,400ft. Mylar base....	25/-
7in.	Long play, 1,800ft. Acetate base.....	15/-
3in.	Message tape, 150ft.	3/6
3in.	Message tape, 225ft.	4/11
3in.	Message tape, 300ft.	7/6
3in.	Triple play, 450ft. Mylar base.....	12/6
4in.	Triple play, 900ft. Mylar base.....	22/6
5in.	Triple play, 1,800ft. Mylar base.....	42/6
5½in.	Triple play, 2,400ft. Mylar base.....	55/-
7in.	Triple play, 3,600ft. Mylar base.....	75/-

P. & P. 1/- extra per reel: 4 reels and over Post Free.

GUITAR PICK-UPS

CGM 5-crystal high imp. pick-up. Clips to fingerboard and plays through any radio pick-up socket or record player amplifier. Size 1½in. × ½in. × ½in., Comp. with lead. **15/11**
WIRECOMP'S PRICE P. & P. 1/-.
CGM35 Magnetic high-imp. Fully adjustable pick-up position carrier. Simply fixed. Separate tone and volume control. Heavy chrome finish. Pick-up size 3½in. × 1½in., control size 2½in. × 1½in. Comp. with long lead and jack plug **59/6**
WIRECOMP'S PRICE P. & P. 1/6.

8 WATT MONO AMPLIFIER

Made by well-known manufacturer. Spec.: 2-EL84, 1-EZ80 and 1-ECC83 Push-pull output. Separate Bass and Treble controls on panel with extended lead.
WIRECOMP'S PRICE £5.5.0 P. & P. 3/6

WIRECOMP ELECTRONICS

378 HARROW ROAD, LONDON, W.9. TEL.: CUNNINGHAM 9530

Hours of Business: 9 a.m. to 6 p.m. Open all day Saturday. Opposite Paddington General Hospital. Buses 18b & 36 pass the door.

14WW—140 FOR FURTHER DETAILS.

TECHNICAL TRAINING by ICS

IN RADIO, TELEVISION AND ELECTRONIC ENGINEERING

First-class opportunities in Radio and Electronics await the **ICS trained man.** Let ICS train YOU for a well-paid post in this expanding field.

ICS courses offer the keen, ambitious man the opportunity to acquire, quickly and easily, the specialized training so essential to success. Diploma courses in Radio/TV Engineering and Servicing, Electronics, Computers, etc. Expert coaching for:

- **INSTITUTION OF ELECTRONIC AND RADIO ENGINEERS.**
- **C. & G. TELECOMMUNICATION TECHNICIANS' CERTS.**
- **C. & G. SUPPLEMENTARY STUDIES.**
- **R.T.E.B. RADIO AND TV SERVICING CERTIFICATE.**
- **RADIO AMATEURS' EXAMINATION.**
- **P.M.G. CERTIFICATES IN RADIOTELEGRAPHY.**

Examination Students Coached until Successful.

NEW SELF-BUILD RADIO COURSES.

Build your own 5-valve receiver, transistor portable, signal generator and multi-test meter—**all under expert tuition.**

POST THIS COUPON TODAY and find out how ICS can help YOU in your career. Full details of ICS courses in Radio, Television and Electronics will be sent to you by return mail.

MEMBER OF THE ASSOCIATION OF BRITISH CORRESPONDENCE COLLEGES.

INTERNATIONAL CORRESPONDENCE SCHOOLS

A WHOLE WORLD OF KNOWLEDGE AWAITS YOU!

International Correspondence Schools (Dept. 222), Intertext House, Parkgate Road, London, S.W.11.

NAME .....

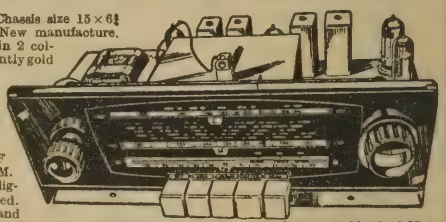
ADDRESS .....
Block Capitals Please

.....

....11.64

14WW—141 FOR FURTHER DETAILS.

BRAND NEW AM/FM (V.H.F.) RADIOGRAM CHASSIS AT £13.13.0 (CARRIAGE PAID)



A.C. ONLY. Chassis size 15 × 6¼ × 5¾in. high. New manufacture. Dial 14½ × 4in. in 2 colours, predominantly gold Pick-up, Extension Speaker, Ae., E., and Dipole Sockets, Five "piano" push buttons — OFF L.W., M.W., F.M. and Gram. Aligned and tested. With all valves and O.P. Transformer. Tone Control fitted. Covers 1,000-1,900 M; 200-500 M; 88-98 Mc/s Valves EZ80 rect., ECH81, EF89, EABC80, EL84, ECC85. 10 × 6in. ELLIPTICAL SPEAKER 25/- to purchasers of this chassis.
TERMS: £3/10/- down and 5 monthly payments of £2/4/-.

ALTERNATIVE DESIGN. LW 1,000-2,000M; SW 9-15 mc/s; MW 190—475M VHF 87-100 mc/s; gram position. Dial dark brown and gold. Otherwise similar to above chassis. Price £15/15/- (carr. paid), terms £3/10/- down and 6 monthly payments of £2/4/-.

HIGH QUALITY PUSH-PULL OUTPUT AMPLIFIER

Chassis 10in. × 7½in. × 7½in. high over trans. Used, guaranteed and in excellent order. New valves EZ40, ECC83 and 2 × EL41; 8 watts. Mains trans. tapped 200-250 volts. O.P. Trans., for 3, 8 and 15 ohm. Choke smoothing. On-Off/Vol. and tone controls. For tuners, Record Players, etc., £3/15/- (P. & P. 6/-.)
We can modify for Guitar input for 15/- extra.

BATTERY ELIMINATOR

For 4 low consumption valves (96 range) 90 v. 15 mA, and 1.4 v. 125 mA., 45/- (4/- post), 200-250 v. A.C. Also for 250 mA. 1.4 v. and 90 v. 15 mA. at same price. Two units to replace existing batteries.

TAPE RECORDER AMPLIFIER

Fully built. Front panel 12½" × 3". Chassis size 10½" × 5" × 4". Valves EF86, ECC83 and 2EL84. Controls (1) MIC. Vol. (2) Tuner/P.U. Vol. (3) Play back or monitor. (4) Tone. 2 jack sockets for Tuner/P.U. and MIC-switch for superimpose. Separate power pack containing transformer and rectifier.
For Collaro studio deck only. Price £8/14/-. (6/- P. & P.)

Send 6d. for 20-page illustrated catalogue. All New Goods. Delivered by return (C.O.D. 2/- extra).
ALL ITEMS GUARANTEED 12 MONTHS. VALVES 3 MONTHS
We regret we cannot execute overseas orders.

GLADSTONE RADIO

66 ELMS ROAD, ALDERSHOT, HANTS. Aldershot 22240. (1 min. from station and buses.) Closed Mondays.

Samson's (ELECTRONICS LTD)

LONDON'S LARGEST SUPPLIERS OF ELECTRONIC EQUIPMENT
9&10 CHAPEL STREET,
LONDON, N.W.1
Tel. PAD 7851 AMB 5125

HEAVY DUTY L.T. TRANSFORMERS

All primaries 220-240 volts. Terminal block connections.

No.	Sec. Taps	Price	Carr.
1	25, 30, 35 v., 40 a.	£11 19 6	10/–
2	25, 30, 35 v., 20 a.	£6 19 6	7/6
3	25, 30, 35 v., 10 a.	£4 15 0	5/–
4	25, 30, 35 v., 2 a.	£1 17 6	3/6
5	10, 17, 18 v., 10 a.	£2 17 6	4/–
6	24 volts, 30 amps.	£7 15 0	7/6
7	20 volts, 30 amps.	£6 15 0	7/6
8	50 volts, 15 amps.	£6 19 6	7/6
9	30, 40, 50 v., 5 a.	£4 15 0	5/–
10	25, 36, 48 v., 8 a.	£4 19 6	5/–
11	17, 18, 20 v., 20 a.	£4 19 6	5/–
12	6, 12 v., 20 a.	£3 12 6	5/6
13	20 v., 20 a.	£4 15 0	7/6
14	30, 32, 34, 36 v., 5 a.	£2 17 6	4/–
15	6, 12 v., 10 a.	£2 2 6	4/–
16	12 v., 5 a.	£1 9 6	3/–
17	24 v., 10 a.	£3 5 0	4/–
18	24 v., 5 a.	£1 19 6	3/6
19	48, 56, 60 v., 1 a.	£1 9 6	3/6
20	12, 24, 30, 48 v., 2 a.	£2 5 0	3/6
21	6.3 v., 15 a.	£1 17 6	3/6
23	12, 24 v., 1 a.	15 0	2/6
24	9, 15 v., 2 a.	17 6	2/6
25	6, 9, 15 v., 4 a.	£1 5 0	3/6
26	12, 18 v., 10 a.	£2 12 7	4/–
27	12, 18 v., 20 a.	£3 19 6	5/–
28	10, 18, 20 v., 9 a.	£3 9 6	5/–
29	15 v. ct., 5 a.	£1 5 0	3/6
30	10, 11, 12 v., 1½ a.	10 6	2/–

Multi-Tapped TRANSFORMERS

Pri. T. 200-250 v. Sec. T. 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 20, 24, 30 v. 5 amps., **47/6**, P.P. 4/–. 4 amps. **39/6**, P.P. 3/6. 2 amps. **25/–**, P.P. 3/–

AUTO. TRANSFORMERS

240v.-110v. Completely Shrouded fitted with 2 Two-Pin American Sockets or Terminal Blocks. Please state which type required. 1,000 watts, **£4/15/–**, carr. 5/–. 500 watts, **£3/10/–**, carr. 4/–. 300 watts, **47/6**, P.P. 3/6, 150 watts, **37/6**, P.P. 3/–. 60 watt, **29/6**, P.P. 2/6. **2,000 watts.** Completely enclosed in metal case. Size: 10 x 8 x 6ins. Fitted with 2 American Sockets or Terminal Blocks, **£9/15/–**, carr. 7/6.

A.M. HEAVY DUTY AUTO. STEP-UP OR STEP-DOWN TRANSFORMERS

Designed for the Air Ministry for mains boosting or operating 110 v. equipment. **10 KVA.** Tapped 250, 240, 230, 220, 120, 115, 110, 105 volts. Completely enclosed in metal case. Size 27 x 17 x 14in. Weight approx. 3 cwt. **£29/10/–. 5KVA.** Tapped as above. Size 23 x 14 x 11in. Weight approx. 2 cwt. **£19/10/–,** Supplied new and guaranteed and offered at a fraction of maker's price. Carr. extra.

TRANSFORMERS LATEST ARRIVALS

Brand new Air Ministry Lt. Trans. Pri. tapped 200-260 v., and 100-130 v. Sec. tapped 28, 29, 30, 31 v., 25 amps. conservatively rated, **£6/19/6**, carr. 10/–. Pri. T. 210-240v. Sec. T. 17, 18, 30, 32 v. 8 amps., **£4/2/6**, carr. 7/6. Pri. T. 200-225-240 v. Sec. T, 12, 18, 20, 24, 30, 36. 10 amps., **£5/5/–**, carr. 7/6. Pri. T. 220-230-240 v. Sec. T. 100-110 v. 200 watts, **45/–**, carr. 5/–. Pri. 240 volts. Sec. T. 53.5-55.2 volts, 6 amps. "C" Core, **£3/17/6**, carr. 6/–. Pri. T, 190-215-235. Sec. T. 63 to 77 v. 3.5 amps. By Advance Components Ltd., **£4/15/–**, carr. 10/–. Air Min. Pri. 220 v. Sec. 110 v. 600 watts or 55 v. 10 amp., double wound, **£5/19/6**, carr. 10/–.

MINIATURE L.T. TRANSFORMERS

Pri. 240 v. Sec. 50 x ½ amp. Size, base 2⅜ x 1¾. H. 2in. by famous maker **10/6**, P.P. 2/–. Pri. tapped 200-240 v. Sec. 30 v. 1 amp. Base 2½ x 2. H. 2½in., **8/6**, P.P. 2/–. Pri. 240 v. Sec. tapped 10, 11, 12 v. 1½ amps. Base 2½ x 2½. H 3½in. **10/6**. P.P. 2/–.

SPECIAL OFFER HIGH GRADE POTTED H.T. TRANSFORMERS BY FAMOUS MAKERS. ALL PRIMARIES. Tapped 200-240 v.

GARDNERS 560-0-560 v. 400 mA. D.C. 5 v. 6 A. 6 v. 0.4 A., **52/6**, carr. 5/–. 350-0-350 v. 75 mA. 6.3 v. C.T. 3 A. 6.3 v., 3 A. 6.3 v. 1 A., **32/6**, carr. 4/–. Sec. T. 1430-0-1430 v. 140 mA. 4 v. C.T. 7 A. 8 v. 4A., **£4/17/6.** 450-0-450 v. 135 mA. R.M.S. 5 v. 3 A. 6.3 v. 4.5 A. 6. 3 v. 2 A. 6.3 v. 1.4 A. 6.3 v. 1.4 A. 12.6 v. 1.2 A., **45/–**. 500-400-0-400-500 v. 250 mA. 4-5 v. 3.5 A. 4-6.3 v. 3 A. 4-6.3 v. 3 A. Unshrouded, **35/–**.

PARMEKO. 600-550-500-0-500-550-600 v. 250 mA. 4 v. C.T. 7 A. 6.3 v. 7.2 A. 6.3 v. 1 A. **69/6.** Sealed 5-4 v. 4 A. 5.1 v. 6 A. 6-4 v. 1 A. 12.6 v. 1 A., **25/–.**

GRESHAM "C" Core, 500-0-500 v. 250 mA. 6.3 v. C.T. 4 A. 6.3 v. 3 A. 6.3 v. 3 A., **55/–**. "C" Core 350-0-350 v. 200 mA. 6.3 v. C.T. 3 A. 6.3 v. 3 A. 6.3 v. 3 A. 6.3 v. 2 A., **45/–**.

GRESHAM FILAMENT TRANS. 4-6.3 v. 2 A. 4-6.3 v. 2 A., **15/–**, 6.3 v. 3 A. 6.3 v. 3 A., 6.3 v. C.T. 5 A., **22/6**, 6.3 v. 5 A. 6.3 v. 0.8 A. and 130 v. 85 mA. **17/6.**

Carr. on all Trans. 5/-.

L.F. CHOKES BY FAMOUS MAKERS.

20 H. 30 mA. 200Ω, **17/6**, P.P. 5/–. 20H. 250 mA. 250Ω, **15/–**, P.P. 4/6. 15H. 250 mA. 130Ω, Sealed "C" Core, **17/6**, P.P. 5/–. 10H. 250 mA. 124Ω, "C" Core, **12/6**, P.P. 3/–. 10H. 75 mA. 400Ω Sealed "C" Core, **7/6**, P.P. 2/6. 1H. 240 mA. 35Ω, Sealed, **7/6**, P.P. 2/6.

WODEN A.C. CHOKES

To pass 100 Amps at 220 v. Base size 6 x 5. Height 4in. Weight 18 lbs. Supplied Brand New in Makers' cartons, **45/–**, Carr. 7/6.

L.T. SMOOTHING CHOKES. 40 MH, 15 A. D.C. Res. less than ½ ohm, **£3/15/–**. Carr. 10/–. 20 MH 250 A. D.C. Res. less than 1/2Ω **£2/17/6.** Carr. 7/6. Other type available.

BLOCK CAPACITORS—Guaranteed

AMERICAN HIGH VOLTAGE CAPACITORS
1 mfd. 20 kV. wkg.

Tropically rated. Size H. 11in. plus insulated terminals, 5in., W. 13in. D. 4in. Supplied new in maker's packing cases at a fraction of original price, **£6/19/6**, Carr. 7/6.

Maker	Mfd.	DCV wkg.	Temp.	Price	Carr.
T.C.C.	10	1,500	70°C	15/–	3/–
U.S.A.	10	1,500	100°C	15/–	3/–
T.C.C.	8	1,500	60 C	17/6	2/6
T.C.C.	8	1,000	60 C	10/6	2/–
G.E.C.	8	600	60°C	7/6	2/–
T.C.C.	8	250	70°C	3/6	1/6
Dubilier	8	1,000	60°C	9/6	2/–
Dubilier	8	750	60°C	8/6	2/–
U.S.A.	7	600	100°C	6/6	1/6
U.S.A.	5	220	100°C	3/6	1/6
T.C.C.	4	2,000	60°C	17/6	2/6
T.C.C.	4	1,000	60°C	7/6	1/6
T.C.C.	4	400	70°C	3/6	1/–
EI	4	800	70°C	5/6	1/6
Dubilier	2	5,000	70°C	35/–	3/6
Dubilier	2	2,500	70°C	17/6	2/6
T.C.C.	2	1,000	60°C	5/–	1/–
T.C.C.	2	500	60°C	3/6	1/–
T.C.C.	1.5	4,000	60°C	12/6	2/6
T.C.C.	1	7,500	70°C	50/–	5/–
T.C.C.	1	2,500	60°C	17/6	3/6
T.C.C.	1	600	70°C	2/6	1/–
Dubilier	1	5,000	70°C	30/–	3/–
T.C.C.	0.5	500	60°C	2/–	1/–
Dubilier	0.5	5,000	70°C	17/6	2/6
Dubilier	0.5	2,500	70°C	8/6	2/–
Dubilier	0.25	5,000	70°C	12/6	3/–
Dubilier	0.25	7,500	70°C	17/6	3/–
T.C.C.	0.25	5,000	60°C	12/6	3/–
B.I.C.	0.1	5,000	60°C	10/6	3/–

		V.A.C.	R.M.S.		
T.C.C.	68	440	—	45/–	4/–
T.C.C.	25	440	—	25/–	3/–
Dominit	22	650	—	27/6	3/–
Dominit	16	650	—	17/6	2/–
Dominit	4	650	—	10/6	2/–
BI	13.5	750	—	22/6	3/–
BI	10	650	—	17/6	2/6

L.T. SUPPLY UNIT TYPE S.E.I.

A.C. input 200-240 v. D.C. Output tapped to give 12 or 24 volts 8 amps, continuous rating. Fitted with panel fuse. Mains on/off switch and D.C. output socket. Built-in strong metal case. Size 15 x 6 x 6in. An ideal general purpose L.T. supply unit for operating relays. Contactors, battery charging, etc. **£9/19/6**, carr. 7/6.

L.T. SUPPLY UNIT TYPE S.E.2
A.C. input 200-240 v. D.C. output 50 volts, 5 amps. Built in metal case size 15 x 6 x 6in. Fitted with on/off switch, panel fuse, and output socket, **£9/19/6**, carr. 7/6.
Tapped 110-220-230 v. D.C. output 24 volts 1.5 amps. 2.25 amps. with case cover removed. Choke and condenser smoothed. Fitted on/off switch and fuses. Built in metal case. Size: 15 x 9 x 9 inches. Supplied new and guaranteed, **£3/17/6**, carr. 7/6.

L.T. SUPPLY UNIT No. 46, A.C. input tapped 110-220-230 v. D.C. output 24 volts 1.5 amps, 2.25 amps. with case cover removed. Choke and condenser smoothed. Fitted on/off switch and fuses. Built in metal case. Size: 15 x 9 x 9 inches. Supplied new and guaranteed, **£3/17/6**, carr. 7/6.

PARMEKO DOUBLE WOUND TRANSFORMERS

Pri. T. 200, 210, 220, 230, 240, 250 v. Sec. T.90, 100, 110, 120 v. Totally enclosed table top connections. Size 7½ x 7½ x 8½in. Brand new, fraction of maker's price. **£11/19/6**, carr. 10/–.

PHILIPS AUTO TRANSFORMERS.

Ideal for mains boosting, tapped 220, 230, 240, 250 v. 600 watts. Brand new, **47/6**, carr. 5/–.

SIEMENS' MINIATURE SELECTOR SWITCHES

Latest plug-in type, 10 way, 3 Bank, 3 Wiper. Type 2,200A 250Ω Size: 3½ x 2½ x 1¼ inches. Complete with Base. Fraction of Maker's price, **59/6**, P.P. 2/6.

HEAVY DUTY SLIDER RESISTORS

Zenith Double Tube Geared Drive Log Wound. 1.3Ω 15 amps. Continuing to 55Ω 2 amps. Overall size: 22 x 9½ x 7½ins. **£3/19/6**, carr. 7/6. 4Ω 8 amps. Single Tube. enclosed, **32/6**, P.P. 4/–. 30Ω 1.25 amps. S. Tube Gear Drive, **25/–**, P.P. 3/–. 1Ω 12 amps. **12/6**, P.P. 2/6. Ganged Twin Rheostats. 6in. dia. 200Ω 1.2 amps. each. Complete with Fixing Frame and Control Knob, **75/–**, carr.

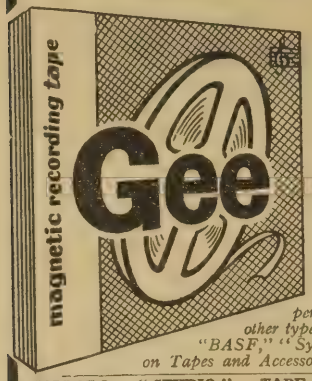
S.T.C. F.W. BRIDGE RECTIFIERS.

Brand New and Guaranteed. Max. A.C. Input 90v. D.C. Output 8½ amps. 7½in. sq. Plates, **£5/19/6**, carr. 7/6. Max. A.C. 72v. D.C. Output 3½ amps. 3½ dia. plates, **50/–**, P.P. 4/–. Max. A.C. 36v. D.C. Output 8 amps. **39/6**, P.P. 3/–. Max. A.C. 18v. D.C. Output 8 amps. 4½in. sq. Plates, **19/6**, P.P. 2/6.

HEAVY CURRENT TRANSFORMERS

Pri. Tapped 105-115-210-230-250v. Sec. 27v. 60A. Totally enclosed. New in maker's cases, **£12/10/0**, carr. 10/–. Pri. 230v. Sec. T. 4.7 11v. 200A., **£10/19/6**, carr. 10/–. Pri. T. 200-220-240v. Sec. T. 50-70 73v. 15A., **£6/19/6**, carr. 10/–. Pri. 200-220-240v. Sec. T. 100-150-155v. 22A., **£9/19/6**, carr. 10/–.

WHY NOT GIVE TAPES FOR XMAS!!



FIRST QUALITY FACTORY FRESH TAPE!

5in.	Std.	600ft.	Mylar	8/6	''GEE'S''
7in.	Std.	1,200ft.	Mylar	12/6	SUPER
5in.	L.P.	900ft.	Acetate	10/-	QUALITY
5in.	L.P.	900ft.	Mylar	12/6	MESSAGE
5½in.	L.P.	1,200ft.	Acetate	12/6	TAPES.
5½in.	L.P.	1,200ft.	Mylar	15/-	3in. Std. 150ft. 3/9;
7in.	L.P.	1,800ft.	Acetate	15/-	3in. L.P. 300ft.
7in.	L.P.	1,800ft.	Mylar	20/-	5/-; 3in. D.P.
4in.	D.P.	600ft.	Acetate	9/-	400ft. 8/6. On
5in.	D.P.	1,200ft.	Mylar	15/-	brightly coloured
5½in.	D.P.	1,800ft.	Mylar	22/6	spools in neat
7in.	D.P.	2,400ft.	Mylar	25/-	plastic cassettes.

Ideal for gifts or messages.

Where not stated, please add P. & P. 2/- per order. (Orders over £3 post free.) Many other types available including "SCOTCH," "EMI," "BASF," "Synchrotape," etc. Send S.A.E. for our huge money-saving literature on Tapes and Accessories. **SPECIAL DISCOUNT FOR TAPE QUANTITIES.**

COLLARO "STUDIO" TAPE TRANSCRIPTORS. Brand new in original cartons. 3 speeds, 10, 3¾, 7½ i.p.s. 3 motors, digital counter, etc. Complete with 7in. spools, instructions and fixings, A.C. 200/230 v. operation. **SPECIAL PRICE £10.** Carr. 7/6.

OUTSTANDING BUYS IN QUALITY MULTIMETERS
100,000 o.p.v. Model 370-N. **Price £14/14/-.**
30,000 o.p.v. Model 500. **Price £8/17/6.**
20,000 o.p.v. Model C.T.500. **Price £5/5/-.**
4,000 o.p.v. Model H.20. **Price 79/6.**
All complete with test leads, battery, instructions and fully guaranteed.

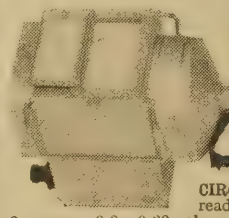
AVO VALVE TESTER. Consists of two parts—valve panel with selector switches and meter with voltage controls, etc. Numerous valve bases including B7G, B8A and B9A. This fine instrument supplied in good condition complete with manual. **£11.** Carr. 7/6.

COSSOR 1035 DOUBLE BEAM OSCILLOSCOPE
A fine instrument in perfect condition and in good working order, **£37/10/-.** Carr. 20/-. Also 1049 at **£45.** Carr. 20/-.

AUTO TRANSFORMERS. Step up, step down, 110/115, 220/230 v. Fully shrouded terminal block connectors. 150 w. **32/6**; 300 w. **47/6**; 500 w. **67/6**; 750 w. **77/6**; 1,000 w. **90/-**; 1,750 w. **175/-**; Carriage 5/- on each type.

RCA PLATE TRANSFORMERS 190 to 250 v. primary 50-60 cycles. Secondary 1,500-0-1,500 v. or 2,000-0-2,000 v. at 500 milliamps. Brand new and boxed **£6/10/-.** Carriage extra.

RECORD MEGGERS
500 volt, with case, perfect order. **Price £12/10/-.**



EVERSHED & VIGNOLES Series II, 500 v. Megger in good cond. **£18/18.**

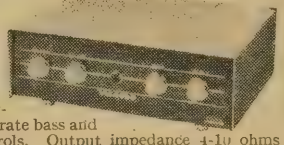
DITTO. NEW with leather case **£25.**

EVERSHED & VIGNOLES MEGGER CIRCUIT TESTER (low reading ohm meter). 2 ranges 0-3, 0-30 ohm. Complete with leather case and test leads. As new, **£6/6.** Ditto 0-500, 100-5,000 ohms **£6.**

EVERSHED & VIGNOLES. Wee Megger 500 w., with leather carrying case, good working order **£15.** Also 100 v., as above, **£6/6/-.**

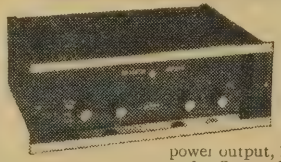
BRIDGE MEGGERS. Evershed and Vignoles Series 2, 500 v. Accurate working order, perfect condition, fully tested. Complete with leather case. **£40.**

ALL TRANSISTOR POWER AMPLIFIER MODEL K3T.

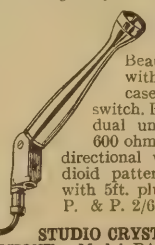


30 WATT 100/250 A.C. mains operation. Separate bass and treble controls. Output impedance 4-10 ohms transformerless. High and low impedance inputs for dynamic or crystal microphone and pick-up. Has 2 separate input channels and 2 separate volume controls enabling input signals to be mixed or faded from one channel to the other. Size 9¾in. × 8 5/6in. × 3in. Complete with circuit diagram and full instructions. **PRICE £26/10/-.** P. & P. 5/-. S.A.E. for leaflet.

JASON TRANSISTOR AMPLIFIERS



200/250 v. A.C. mains operation. Separate bass and treble controls, 10 watt power output, 15 ohms output impedance. Inputs for Gramophone, Radio, Tape. Complete with circuit diagram and full instructions. Brand new with maker's guarantee. Originally £22. **OUR PRICE £14.** Few only!



DUAL IMPEDANCE SLIM DYNAMIC MICROPHONE. Model PA.46. Beautiful, professional-looking, with solidly cast, tapered slim case. Heavy duty on-off slide switch. Built-in transformer supplies dual unbalanced impedances—low 600 ohms, high 50,000 ohms. Omnidirectional when used vertically—cardioid pattern when tilted. Complete with 5ft. plug-in cables. **PRICE £4/4/-.** P. & P. 2/6.

STUDIO CRYSTAL MICROPHONE. Model PA.17. A fine quality all directional microphone with a 360° pick-up and the added power and sensitivity of two individually shock mounted and phased crystal cartridges, giving maximum pickup from all sides. Overall size 7in. H. × 8in. W. complete with 4ft. cable. **PRICE £2/2/-.** P. & P. 2/6.

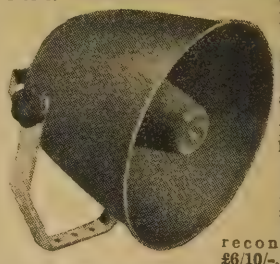
"DYNA-SLIM" MICROPHONE
MODEL PA.43. Dynamic 30K high impedance microphone with on/off switch. Omnidirectional head. Length 8in., 1¼in. dia.tapered. Complete with cable and connector. **69/6.** P. & P. 2/6.

CRYSTAL MICROPHONE MODEL BM.3
Three-way mike for hand, desk or floor stand use. Response 100-8,000 c/s. Sensitivity—62 dB. Length 7in. Head dia. 1¼in. Supplied with neck band, lead and standard jack plug. ONLY **39/6.** P. & P. 2/-. Table stand 12/6 extra.

MICROPHONE FLOOR STAND (Telescopic). HEAVY 9in. dome, chromium base, chromium stand with screw top. Extends to approx. 6ft. **55/-.** Carr. 5/-.

WANTED FOR CASH !!
Good quality modern P.A. Equipment. Test Equipment, Hi-Fi Equipment, what have you! Single items or quantities. Offers by return.

P.A. EQUIPMENT

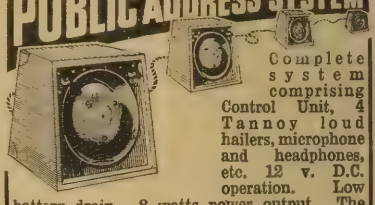


RE-ENTRANT LOUD HAILERS (Ex Govt.) Heavy duty 20 watts., all metal, 15 ohms. Dia. 15in., length 15in. (approx.). Brand new and boxed, **£9.** Carr. 10/-. Ditto reconditioned, **£6/10/-.** Carr. 10/-

EXPONENTIAL HORNS BY FAMOUS MAKER OF P.A. SYSTEMS
20 watt, 15 ohm speech coil, 30in. long, 20in. square flare. Good condition. **FEW ONLY. £7/10/-.** Carr. 12/6.

10 inch P.M. HEAVY DUTY SPEAKERS
Complete in all steel blue-grey double grille cabinet, **39 6.** Carr. 6/-.

PUBLIC ADDRESS SYSTEM



Complete system comprising Control Unit, 4 Tannoy loud hailers, microphone and headphones, etc. 12 v. D.C. operation. Low battery drain. 8 watts power output. The ideal system for mobile use, outdoor meetings, sports days, factories, garden fetes, etc. Speakers can be spaced effectively over hundreds of yards. Guaranteed Brand New in sealed cartons. Price **£10/10/-.** Carriage **15/-.** *L.T. SUPPLY ACCUMULATORS available as follows:* 12 *Volt* 25 *A.H.* **50/-**; 2×6 *Volt.* 20 *A.H.* **35/-.** *Carriage extra.*
TANNOY LOUD HAILERS available separately **30/-** each. Carr. 5/-. Spare diaphrams **12/6** each.

15 WATT TRANSISTOR POWER AMPLIFIER
A new transistor Audio Frequency Amplifier of new modern design incorporating a number of additional practical features. Operates on 12 volts. Power output 15 watts. Output impedance 25, 15 or 3.75 ohms. Inputs for mike and gram. Frequency response 100 c/s. to 10 kc/s. Incorporates on/off switch, volume control, tone control, pilot lamp. Complete in pale green hammer finish metal case, size 6 × 3½ × 5¾in. Weight 4¼ lb. Made in England. Brand new and fully guaranteed. All parts replaceable. **ONLY £21.**

G.P.O. STANDARD 19in. HEAVY DUTY EQUIPMENT RACKS
4ft. 6in. Channel Uprights, **£4.** Carr. 15/-.
5ft. 6in. Angle Uprights, **£4/10/-.** Carr. 15/-.
6ft. Channel Upright, **£6/10/-.** Carr. 20/-.
7ft. Channel Upright, **£8.** Carr. 20/-.
All with Heavy Duty Base.

'POWERSTAT' VARIABLE TRANSFORMERS
Input 230 volts. 50/60 cycles. Output 0-260 volts at 9 amps. Fully shrouded. For bench or panel mounting. A robust job of outstanding quality and performance. Brand new and guaranteed. **£15.** Carr. 7/6. Made in U.S.A.

GEE BROS. RADIO LTD.

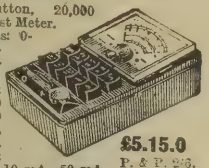
15 LITTLE NEWPORT STREET, LONDON, W.C.2 GER. 6794/1453

Open 9-6 Mon. to Fri. 1 p.m. Sat.
Adjoining Leicester Square Tube

SOUTH SUPPLIES
(ELECTRICAL) LTD.
POST ORDERS TO OLD KENT RD. ADDRESS

95, OLD KENT RD. S.E.1 BER 5810
72, BOROUGH HIGH ST. S.E.1 HOP 2125
90, HIGH ST., EDGWARE. EDG 6751
17, WOODFORD AVE., ILFORD CRE 4815

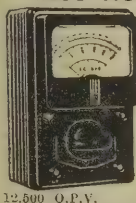
EECO MODEL S.E.37B



Push button, 20,000 O.P.V. Test Meter. D.C. Volts: 0-1-10-50-250-500-1,000. A.C. Volts: 0-10-50-250-500-1,000. D.C. Current: 0-50 mA., 10 mA., 50 mA. Resistance: 0-5 kΩ-500 kΩ-5 MΩ. Inductance: 50 H.—5,000 H. Capacitance: 150 pF-0.02 μF. D.B.: —20Ω + 22.D.B., 20Ω, 36 D.B. **THE SIMPLEST AND MOST EFFICIENT METER ON THE MARKET AT £££'s BELOW ITS TRUE VALUE.**

£5.15.0 P. & P. 2/6.

EECO MODEL S.E.550



100,000 O.P.V. PROFESSIONAL TEST METER. **Highest Accuracy:** 3% on D.C.V.—amps.—ohms. 4% on A.C.V. **D.C. Volts:** 0-0.5-2.5-10-50-250 at 100,000 O.P.V. 0-500-1,000 at 35,000 O.P.V. **A.C. Volts:** 0-2.5-10-50-250-1,000 at 12,500 O.P.V. **D.C. Amps.:** 0-10 μa. at 500 mV. 0-250 μa.-2.5 mA.-250 mA.-10 at 150 mA. **Resistance:** 0.20 m.-2 m.-200 k.-20 k. 160 k.-16 k.-160Ω. Centre scale. **Decibels:** —20 to 62 (0 db = 0.775 v.).

£7.19.0 P. & P. 3/-.

MULTI METER BARGAIN MODEL TK20A

1,000 O.P.V. on both A.C. and D.C. A.C. and D.C. volts.: 0-15, 0-150, 0-1,000 v. D.C. Current: 0-150 mA. Resistance: 0-100 k. Size: 3¾in. × 2¾in. × 1¾in. Meter Size: 2¼in. × 1¾in. Complete with test prods and battery. Wonderful value at **31/6**, plus 1/6 P. & P.

AMERICAN RECORDING TAPES

5in.	Stnd. 600ft.	9/6
5in.	L.P., 900ft.	12/-
5in.	D.P., 1,200ft.	15/-
5½in.	L.P., 1,200ft.	15/-
7in.	Stnd., 1,200ft.	15/-
7in.	L.P., 1,800ft.	17/6
7in.	D.P., 2,400ft.	25/6

The Quality American Recording Tape with 100% Guarantee. Try it yourself.

ELAC SPEAKER OFFER

5in. Speaker	8/6
6in. Speaker	11/-
8in. Speaker	11/-
7" × 4" Speaker	11/-
4in. Rola Celestion	9/6

P. & P. 3/-.

EXTENSION SPEAKERS IN CABINETS

5in., 25/-. 7in. × 4in., 2-tone modern design with vol. control, 35/-. 8in., with vol. control, 35/-. P. & P. 4/6.

TRANSISTOR RADIO EXT.

Speaker in handsome wood finish cabinet. Complete with ext. lead, 2.5 mm. and 3.5 mm. plug to fit any type radio. 22/6. P. & P. 1/6.

3-WAY COLUMN SPEAKER.

With two 7in. x 4in. speakers and one 4in. tweeter. Ready built, 3/5 ohms input, 2-tone cabinet. Size 23½in. x 5½in. x 4in. Wonderful value at only **£2/19/6**, P. & P. 6/6.

RONETTE BINOFLUID B.F.40 STEREO CARTRIDGE

Freq. Res. 30-12,000 c/s. Sensitivity 180 mV./cm./sec. Load 1 MΩ 100 pF. Complete with Sapphire Stylus. Our Price 12/6 ea. P. & P. 1/-.

RONETTE STEREO O.V.S. TURNOVER CARTRIDGE

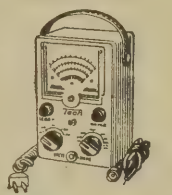
With 2 Sapphire Stylus. Our Price 19/6 ea. P. & P. 1/-.

Acos 45

Die cast, hand shaped body. Special offer, 15/6 plus P. & P. 2/6.

TELEPHONE PICK UP

For use with any type tape recorder. wonderful value. 5/9. Post paid.



TECH. MODEL PV-58 VACUUM TUBE VOLTMETER

Finest design for stable and accurate measurement. 1% tolerance on all resistors. Large design 4in. 200 a. meter for accurate readings 11 megohm input.

Ranges:
— D.C.V. 0-1.5-5-15-50-150-500-1,500 v.
+ D.C.V. 0-1.5-5-15-50-150-500-1,500 v.
A.C.V. 0-1.5-5-15-50-150-500-1,500 v. R.M.S.
0-1.4-4-14-40-140-400-1,400-4,000 P.P.

Resistance. 2 ohms to 1,000 megohm.
Decibels. —10 db. to +65 db.
Operation. 220/240 v. A.C. Size 7in. × 4¾in. × 4in.

Each tester is supplied brand new and fully guaranteed complete with probe and operating instructions.

The finest value in tester available at only **£12/19/6** Complete. P. & P. 3/6 ex.

EECO MODEL S.E.100 TRANSISTORIZED VARIABLE D.C. POWER SUPPLY

METER RANGES	Voltage Range
Volt. 0-20 V.D.C.	0-20 volts.
Current 0-20 mA.	Continuously variable.
0-200 mA.	

Maximum Current Cap. 0-10 v. 200 mA. Intermittent. 0-20 v. 150 mA. continuously.
Impedance Source. Current position. 3.3 ohms. Voltage position 0.2 ohms.
Power Input. 220/240 v. Size 6in. × 3¾in. × 2¾in.
Fuse. 0.5 amp., slow blow, in D.C. circuit.

The extremely wide variable voltage range, low A.C. ripple and source impedance of the S.E.100 makes it a most satisfactory power supply to operate transistor radios, hearing aids, pre-amplifiers, instruments and other electronic devices under repair. The S.E. 100 can be used in television and radio servicing, as an A.V.C. or A.G.C. voltage source as a D.C. filament supply, operate relays, recharge small batteries and light electro plating as in dentistry.

£6/10/0 P. & P. 4/6. Fully guaranteed and complete with test lead, croc. clips and operating instructions.

EECO MODEL S.E.200 MINI-LAB TESTER

This remarkable meter has seven test instruments packed into one pocket size case which can be taken and used anywhere. *Resistance Substitution.* 100Ω, 1KΩ, 10KΩ, 100KΩ, 1MΩ. *Capacitance Substitution.* .002 mfd.-.005 mfd.-.02 mfd.; .1 mfd. and 10 mfd. *R.F. Signal Generator.* Frequency fixed at 445 Kc/s (adjustable to 700 Kc/s), output 35 mV approx. *Audio Generator.* Frequency 400 c/s. Output 35 mV. approx. *D.C. and A.C. Volts.* 4 ranges, 0-15-50-150-500 volts at 4,000 O.P.V. *R.F. Field Strength Indicator.* Frequency range 1 to 140 Mc/s Antenna 5 sections, length 10¾in. *Size* 6in. x 2¾in. x 3¾in. The Mini-Lab is completely battery operated and suitable for quick checks in the service shop and Home Service calls. £8/19/6 each. Complete with Test Prods and Battery, fully guaranteed.

EECO MODEL MS4 FLOORSTAND

Height fully open 55½in. Fully closed 33in. Three sections, fully telescopic. ¾in. or ⅝in. mic. adaptor.

39/6 ea. P. & P. 5/-.

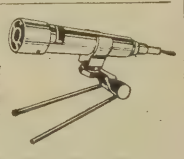
Heavy cast iron base. Wonderful value.

DM 260 DYNAMIC MIC.

Sub-miniature type, complete with stand,

52/6

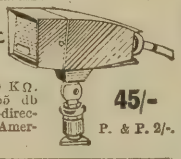
P. & P. 2/-.



MC 110 CRYSTAL MIC.

With on/off switch and holder. Satin chrome finish.

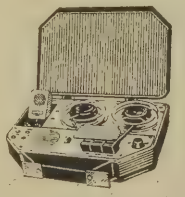
26/6 P. & P. 2/6.



MD 175 DYNAMIC MIC.

Impedance 50 KΩ. Sensitivity: 55 db at 1,000, non-directional, latest American design.

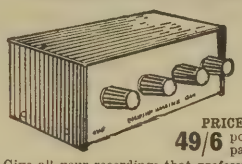
45/- P. & P. 2/-.



HOMEY 4 Transistor Tape Recorder. Power output 180 mW. Freq. response 500-4,000 C.P.S. Recording D.C. bias ⅓ track Wow and Flutter less than 2% Signal to noise ratio 25 dB. (1,000 c/s). Built-in 2½in. p.m. speaker. Battery life approx. 10 hrs. Remote control switch on microphone gives many more uses to this tape recorder. It also has a built-in amplifier socket for telephone amplification. Many other uses. It comes complete with microphone —personal earpiece—3in. Tape. Spare spool and Batteries. All this for only **£5/15/-**. plus 5/9 P. & P. (Fully guaranteed.)

SUN ACE 4 4 transistor new push button Super de-luxe Tape Recorder. Circuit—4 transistors. Recording D.C. bias ⅓ track, built-in 2½in. p.m. speaker. Recording time 17 mins. approx. on 200ft. tape. Batteries 1U 2-1 PP3. Complete with crystal microphone—personal earphone. 200ft. Tape and reel. Spare spool. Carrying strap and Batteries. Wonderful value at only **£4/15/-** plus 4/9 P. & P. (Fully guaranteed.)

EECO 4-Channel Transistorised MICROPHONE MIXER



PRICE **49/6** post paid.

Give all your recordings that professional touch. The Eeco mixer allows you to mix 4 signals such as Mic., tape, records and tuner into a single output. Wonderful for groups, amateur recorders, etc. Guaranteed to give hours of pleasure.

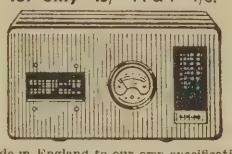
FAMOUS MAKE AMPS. AND PRE-AMPS. at Vastly Reduced Prices

3-4 watts, **£4/15/-**; 4-5 watts, **£5/7/6**; 5/5 Stereo, **£11/5/-**; 10 watts, with separate pre-amp., **£14/3/6**; 30 watts, **£15/2/6**; 50 watts, **£20/14/3**; Tremolo unit, **£3/15/6**; tape pre-amp., **£8/10/-**.

Miniature Push-Pull Audio AMPLIFIER

4-transistor, output 200 m.w., low and high gain, inputs to operate 3Ω speaker. Wonderful value, **31/6**. P. & P. 2/-. Complete with operating instructions.

A GENUINE 4-AMP. BATTERY CHARGER for only 45/- P. & P 4/6.



Made in England to our own specification and fully guaranteed.
High-Low-Med. Change Rate. 6 v. or 12 v. Selector Plug. 200/250 v. Mains Selector Plug. 4 amp. cartridge fuse protection, complete with mains lead, charging lead, and croc. clips.

Maxwell Battery Charger

For your PP3 transistor radios, works direct from the mains. Our Price **15/6** plus 9d. P. & P.

HIGH IMPEDANCE HEADSETS

2,000Ω or 4,000Ω. Lightweight. Cream earpieces. **13/6**. P. & P. 2/6.

VANTONE MAINS RADIOS

5-valve superhet with built-in Ferrite tuning bar.

£3/15/-

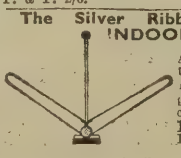
plus P. & P. 3/9. Fully guaranteed.

This wonderful little radio will receive all stations on med./wave loud and clear inc. Luxembourg. Ideal for bedrooms, kitchens, or as a second mains radio.

INTERCOM/BABY ALARM Fully Transistorised

Size 4 × 2½ × 1in. Complete with 60ft. of twin flex. P.P.3. batt. Push to call on sub station. Push to talk on master and vol. control. Our price **55/6**. P. & P. 2/6.

The Silver Ribbon 625 INDOOR AERIAL



Also for 405, ITV — BBC and F.M. Complete with co-ax. plug. **19/6**. P. & P. 1/-.

Wilkinsons FOR RELAYS

P.O. TYPE 3000 AND 600

BUILT TO YOUR REQUIREMENTS—QUICK DELIVERY
COMPETITIVE PRICES—VARIOUS CONTACTS
QUOTATIONS BY RETURN

MINIATURE SEALED RELAYS

OVER 120 TYPES IN STOCK. SEND FOR LIST.

SIEMENS 1 C.O.			
2.2Ω+2.2Ω		H96A	**18/6**
50Ω+50Ω		H96B	**19/6**
145Ω+145Ω		H96C	**19/6**
1,700Ω+1,700Ω		H96E	**22/6**
G.E.C.			
2,500Ω	4CO	M1008	**19/6**
2,500Ω	1CO	M1022	**15/-**
5,000Ω	2CO	M1052	**17/6**
670Ω	2m2bHD	M1095	**17/6**
2,500Ω	2C2K	M1417	**19/6**
5,000Ω	2CO	M1452	**17/6**
2Ω	2mHD	M1454	**15/-**
2,500Ω	2mHD	M1458	**15/-**
2,500Ω	1m1bHD	M1462	**15/-**
40Ω	2CO2K	M1482	**19/6**
180Ω	1CO	M1486	**15/-**
180Ω	2m2bHD	M1487	**17/6**
180Ω	2C2K	M1490	**19/6**
670Ω	2C2K	M1493	**19/6**
670Ω	4K	M1567	**19/6**

S.T.C.			
45Ω	1mHD	4186EB	**19/6**
170Ω	1mHD	4186EC	**19/6**
700Ω	2COMD	4190HD	**19/6**
2,500Ω	2CO	4184GE	**19/6**
2,500Ω	1mHD	4190EE	**19/6**
ERICSSON			
7,000Ω	1CO	N22242A10	**25/-**
260Ω	1CO	N22372AC1	**15/-**
5,000Ω	1CO	N22372AE1	**15/-**
7,500Ω	2CO	N22365AZ1	**17/6**
1.1Ω	4CO	N22364AA1	**19/6**
1.1Ω	2CO2K	N22366AA1	**19/6**
1,500Ω	2CO2K	N22366AE1	**19/6**
2.4Ω	2M	N22371AA1	**15/-**
180Ω	2M	N22371AC1	**15/-**
2,000Ω	2M	N22371AE1	**15/-**
2.4Ω	1m1b	N22370AA1	**15/-**
52Ω	1m1b	N22370AB1	**15/-**
1,500Ω	2m2b	N22369AE1	**17/6**
7,500Ω	2m2b	N22369AZ1	**17/6**

CARPENTER Polarized Relays. 5A7 55+55Ω also 5HM19A 28+28Ω **45/-** each.

MINIATURE UNISELECTORS. Plug-in type. Occupies no more space than a P.O. 3000 Relay. Siemens No. 2200A, 3 level, 12 outlets, 50 volts, 1 bridging and 2 non-bridging wipers. Supplied complete with Jack. Other types available including REVERSIBLE. EACH 90/-

KEY SWITCHES (3 position). P.O. 212. 2 Changeover each side, **6/6.**
P.O. 198. 4 Changeover each side, **13/6.**
Other types available., Knobs, **6d.** Plates **1/-.**

RELAYS MAGNETIC SOLENOID OPERATED

24 volts D.C. 4 make and 4 break 10 amp. contacts. 5C/3944. Brand new, with dust cover, **12/6** each, post 2/-. Suitable for Automatic Machines.

WEE MEGGER INSULATION TESTERS. SERIES 3, 500 VOLT. BRAND NEW in leather carrying case £18/10/-.

RACKS—POST OFFICE STANDARD. 6ft. high with U-channel sides drilled for 19in. panels, heavy angle base.
CONTACT COOLED RECTIFIERS. Half wave, 250 volts, 85 milliamps. **8/-** each, 250 volt, 120MA, STC type No. C3D, **7/6** each. Post 6d.
SILICON RECTIFIERS. BEST GRADE 800 PIV, 500 milliamps., **6/6** ea. 600 PIV 700 milliamps., STC RS27AF, **15/-** each. 200 PIV up to 70 volts RMS, 6 amps., **10/-** each. 100 volts 200 milliamps., **2/6** each; 50 for **100/-.**
CHARGING RECTIFIERS. 12 v. 6 amp., **20/-** each; 24 v. 8 amp., **40/-** each.
TRANSISTORS. OC44 **8/-**; OC45 **8/-**; 2S002 **15/-**; OC71 **6/6**; OC200 **15/-**; V30-30P **10/6.**
THERMAL DELAY SWITCH. Glass enclosed 4-pin base. Switches 6 amp. 250 volts in 1 minute from 4 volt 1.5 amp. heater. **7/6** each. Post 1/6.
POTENTIOMETERS, WIREWOUND AND CARBON including Sub-miniature, Sealed and Precision types—comprehensive list now ready.
PRECISION SILVER MICA CAPACITORS, 0.1 mfd. ½%, **6/-** ea.; 1% **5/-** ea.
TANTALUM ELECTROLYTICS. 50 mfd. 70 volts, **7/6** ea.; 140 mfd. 30 volts, **12/6** ea. Various other values available.
BLOWER MOTORS. 200/250 volt Capacitor Type 2,800 r.p.m. Cylindrical casing 7in.×7in.×7in. with open flange each end **£12/10/-.**
24-WAY DOUBLE POLE PAXOLIN WAFER SWITCHES. 12/6. Post 1/6.
21-WAY STUD SWITCH with Metal Cover fitted with Attenuator Resistors. **25/-.** Post 1/6.
DOUBLE HEADPHONES. High resistance 4,000Ω, **14/6.** Post 2/6.
DOUBLE HEADPHONES, sound powered. Type DHR, **17/6.** Post 2/6.

ONE HOLE FIXING SWITCHES

12/- per dozen 75/- per 100

SINGLE-POLE Double Throw, 3 amp. 250 A.C
Can be used as ON/OFF or CHANGE-OVER SWITCH.

Also available in DOUBLE POLE ON/OFF, **18/-** per doz.; **£5** per 100. PUSH BUTTON SINGLE POLE DOUBLE THROW SP101 (10F/1786), **6/-** ea. OTHER TYPES STOCKED IN QUANTITY—SEND FOR FULL LIST. Double Pole on/off, 30 amp., 250 v., dia. H 2DP, **8/6** ea.; **90/-** doz. Double Pole Change Over, 3 amp. 250 v. NSF., **3/6** ea.; **36/-** doz.
WAFER SWITCHES. Miniature 2-pole 2-way, 2 pole 6-way, **3/-.** Standard 4-pole 3-way, **3/6;** 2-pole 11-way, 6-pole 3-way, **5/-;** 8-pole 6-way, **7/6;** Ceramic 2-pole 11-way, **12/6;** Wearite 12-pole 3-way, 18-pole 2-way, **7/6.**

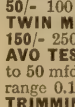
Microammeters, Milliammeters, Voltmeters

BEST MAKES ★ DELIVERY OFF THE SHELF ★ SEND FOR LISTS

2½in. Moving Coil Flush Round
10-0-10 Milliamp, **35/-;** 50 Milliamp, **35/-;** 100 Milliamp, **25/-.** Proj. Round 50 Microamps. Special scale, **45/-.** All D.C.; 100 Microamps, A.C. **85/-.**
3½in. MC Flush Round 100-0-100 Microamp, **70/-;** 10 amp. **45/-.**
2in. Moving Coil Flush Round
0/1 Milliamp.; 0/5 Milliamp.; 0/10 Milliamp.; 0/20 volts; 0/30 volts; 0/40 volts; 0/5 amp. all at **27/6** each.
2in. Moving Coil Flush Square
0/1 Milliamp. at **37/6. Postage on all meters 2/-.**
CATHODE RAY TUBE. 139A. 2½in., **25/-.** Post 2/-.
FREQUENCY METERS. 45-55 cycles per second, 230 volt, 6in. dia. Flush Round. Brand new in maker's box. **£10/10/-,** post 5/-.
UNI-PIVOT GALVANOMETER, by Cambridge Instruments, 50-0-50 microamps., dia. 4in. Knife pointer, mirror scale. **£10,** post 3/-.
PORTABLE AMMETER. 0-3 amp. A.C./D.C., 3in. scale, **35/-,** post 2/6.
AMMETER, reading 50-0-50 amp., 2in. Flush Square, **17/6** each, post 2/-.
VOLTMETER. A.C. 0/300 2½in. Flush Round, **25/-,** post 2/-.
MILLIAMETER. 0/100 D.C. 9in. PR. Have a meter you can read easily, **150/-.**
CELL-TESTING VOLTMETERS. 3-0-3 volts D.C. In leather case with prods. Just the job for the car. **25/-** ea., post 2/6.
METER RECTIFIERS. 1 mA., 5 mA., F.W. bridge, **8/6,** post 6d.
JACK PLUGS. Cylindrical Bakelite screw-on cover, 2 contact, **2/6,** post 6d. Large quantities available. Also P.O.201 on headphone cord 10H/117 **3/-** ea. Post 1/-.

MINIATURE JACK PLUG AND SOCKET. Bulgin P519/J30 **3/6,** post 6d.
AUTO TRANSFORMERS by S.T.C. Totally enclosed C core type. 110-250 volts. 8 tappings, 50 cycles, size 6½×5½×5½, 500 watts. New latest type **£4.**
MAINS TRANSFORMER. Input 200/250 volts. Output 300-0-300 volts, 250 mA., 6.3 volts, 9 amps. **25/-.** Post 3/9.

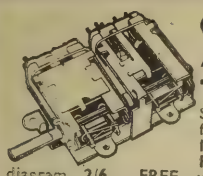
WESTALITE BATTERY CHARGERS. Made by Westinghouse (type BC14-6/40). Input 200/250 v. A.C. will charge 6-volt or 12-volt batteries at 0/40 amps. Coarse control switch with eight positions and fine control switch with four positions including "off." Built-in 0-50 ammeter. Fused A.C. and D.C. 24in.×14in.×13in.; **£39/10/-,** each. Carriage 20/-.
15-AMP. BATTERY CHARGER. (Westinghouse Type BC.3) will charge three lead acid cells at 15 amps. Input 200/250 volts, 50 cycles A.C. Charging current regulated by four-position switch and variable resistance for fine control. Fitted with 0/20 ammeter, rotary on/off switch and rewirable fuses. **£8/10/-.** Carriage 15/-.
LEDEX SOLENOID-DRIVEN WAFER SWITCHES. Size 5S. Approx. 24 v. with standard size wafers. Available in 4-bank, 14-bank, 24-bank, all 1-pole, 11-way. Also 4-bank, 1-pole, 12-way, from **90/-.**
LEAK DETECTORS. B.T.H. Portable type mains operated. **£45.**



MINIATURE SILVER ZINC ACCUMULATOR. 1.5 volt, 1.5 ampere. Size 2in. × 1.13in. × 0.63in. Weight 1¼ oz. Ideal for model work. **12/6** ea., **120/-** doz. post 9d.
STROBOSCOPE FORK. 125 cycles. P.O. No. 5, **30/-** ea., post 2/-.
RATIO ARM UNITS. Sullivan 600Ω+600Ω, **50/-,** post 3/-.
MIRROR GALVANOMETERS BB 3000. N.E.P. Focal length 20 cm., **£18.**
MICRO SWITCH. Burgess MK4BR, robust die cast casing, **8/6** ea., post 9d.
SUBMINIATURE MICRO SWITCHES HONEYWELL. 11SM1-TN13. S.P.D.T. Size .781in.×.250in.×.356in. **6/6** each. Full details on request. Quantities available at low prices.
MINIATURE BUZZERS. 12 v. with adjustable tone. **7/6.**
BUZZERS. 230V. Ironclad Gents P367AC **50/-.** Post 3/6.
HIGH NOTE BUZZERS. 24Vt. AC/DC. with tone adjuster, 2¾in. dia. bakelite case, **10/6.** Post 1/6.
BELL SETS. No. 25 AC bell, induction coil, condenser. For telephones **17/6.** Post 3/-.
RINGING GENERATORS for above **10/6.** Post 2/6.
SINGLE FLEX 14/0048. Screened and PVC sheathed overall **50/-** 100 yd. coil.
TWIN MICROPHONE FLEX 7/004 Screened, PVC overall **150/-** 250 yd. coil.

AVO TEST BRIDGES. 220/240 volt A.C. Measure capacities from 5 pf. to 50 mfd. and resistances from 5 ohms to 50 megohms. Valve volt-meter range 0.1 to 15 volts and condensers leakage test. **£9/19/6,** post 5/-.
TRIMMING CONDENSERS. Air spaced miniature 1.5 to 8 pf., 1.5 to 20 pf., 2 to 32 pf., 20 pf. All at **1/6** each, post 3d.
RESISTORS WIREWOUND AND HIGH STABILITY CARBON inc. Erie 109, 108 and 100, ex stock in quantity. Write or phone your requirements.

L. WILKINSON (CROYDON) LTD.
LONGLEY HOUSE LONGLEY RD. CROYDON SURREY
Phone: THO 0236 Grams: WILCO CROYDON



CYLDON A.M./F.M. PERMEABILITY TUNER FOR ALL TRANSISTOR OPERATION

Size 2½in. x 2⅛in. approx. By famous manufacturer. A.M.-I.F. 470 Kc/s. F.M.-I.F. 10.7 Mc/s. A.M. coverage from 1,620 Kc/s-525 Kc/s. F.M. coverage 108 Mc/s.-88 Mc/s. Circuit diagram 2/6. FREE with Tuner. 1st, 2nd, 3rd A.M.-I.F.'s 1st, 2nd, 3rd and 4th F.M.-I.F.'s V.H.F. Osc. choke A.M.-F. trap. A.F. 114 and A.F. 115. All the above are the R.F. end of an AM/FM receiver car radio etc. The above six items. **£2 . 10 . 0**

BSR MONARCH UA14 With FUL-FI HEAD

4-speed, plays 10 records, 12in. 10in. or 7in. at 16, 33, 45 or 78 r.p.m. Intermixes 7in. 10in. and 12in. records of the same speed. Has manual play position: colour, brown. Dimensions: 12½ x 10⅜in. Space required above baseboard 4⅜in., below baseboard 2⅜in. Fitted with Ful-Fi turnover crystal head, **£5/19/6.** P. & P. 6/6.

B.S.R. UA16, similar to the above, **£6/12/6** P. & P. 6/6.

B.S.R. GU7, 4-speed, single player, complete with pick-up on uniplate with automatic switch. **£3/19/6.** P. & P. 5/6.

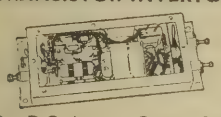
FLUORESCENT LIGHT KIT

40 watt fluorescent lighting kit comprising Siemens Choke, 2 Bi-pin holders, Starter Holder and Starter. **11'6** Plus 3/- P. & P.

TWIN 20 CHOKE instant start complete with 4 bi-pin 200/250v holders. **11'6** P. & P. 4/-

TWIN 40 CHOKE instant start with 4 bi-pin 200/250v. holders **17'6** P. & P. 4/-

TRANSISTOR INVERTOR



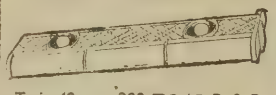
50v. D.C. Input. Output 240v. A.C. 40 Watts incorporating transformers, choke, condensers and 2 Gec 573. In solid 16 gauge Aluminium Case size 15in. x 6in. x 2¼in. by famous manufacturer. **19/6** plus 6/- P. & P.

AC MAINS MOTOR

Can be used for a variety of purposes, silent running, satisfactory in every way, 230/250 v. A.C.

9/6 P.& P 2/-

FLUORESCENT LIGHT FITTING

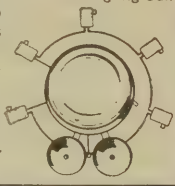


Twin 40 watt 200 250 v. less tubes. **59/6** P. & P. 6/-

RINGO BURGLAR ALARM

A.C. Mains 200/240 volt. Fire salvage slightly tarnished.

List price 7 gns. Our price complete with double gong bell five micro switches and full instructions



49/6

P.& P. 4/-

SILICON RECTIFIERS 250v. P.I.V. 750 milli-amps. Six for **7/6d.** post paid.

BARGAINS

TO SEE FROM

R & T V

SIGNAL GENERATOR

Covering 100 Kc/s.-100 Mc/s. on fundamental and 100 Mc/s. to 200 Mc/s. on harmonics. Metal case 10in. x 6⅜in. x 5¼in., grey hammer finish. Incorporating three miniature valves and metal rectifier. A.C. mains 200/250v. Internal modulation of 400 c.p.s. to a depth of 30%. Modulated or unmodulated R.F. output continuously variable, 100 millivolts C.W. and mod. switch, variable A.F. output. Incorporating magic-eye as output indicator. Accuracy plus or minus 2%. **£7/5/0** Post and packing 6/6 extra.

MAINS TRANSFORMERS

ALL WITH TAPPED PRIMARIES 200/250 VOLTS

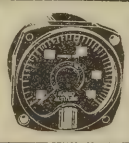
250-0-250 v. 60mA., 6.3 v. 1.5 amp., 6.3 v. 1 amp.	11/6
250-0-250 v. 80 mA., 6.3 v. 1.5 amp., 6.3 v. 1 amp.	15/-
250-0-250 v. 50 mA., 6.3 v. 2 amp.	9/6
250-0-250 v. 250mA., 6.3 v. 5 amp.	19/6
Heater Transformer 6.3 v. c.t. 2 amp.	7/6

Postage and packing on all the above transformers 4/-.

Primary 230-240 v., Secondary 330-0-330 v. 200 mA., 6.3 v. c.t. 6 amp., 5 v. 4 amp. 21/-. P. & P. 6/-.

POCKET MULTI-METER. Sizes 3⅞ x 2⅛ x 1⅜in. Meter size 2⅛ x 1⅜in. Sensitivity 1,000 O.P.V. on both A.C. and D.C. A.C. and D.C. volts 0-15, 0-150, 0-1,000. D.C. current 0-150 mA. Resistance 0-100KΩ. Complete with test prods, battery and full instructions. 35/-. Plus 1/6 P. & P

50 MICRO-AMP. METER Movement by world-famous manufacturer. Size 3in. x 2⅜in. 25/- plus 1/6 P. & P

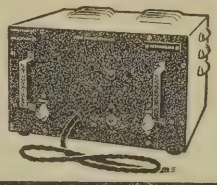


THE MOTORIST'S REV. COUNTER

Kit of parts comprising 270 degree 3in. moving coil movement. Manufacturer's present price of this movement would be at least £7. Complete with full instructions and circuit diagram. Scale calibrated up to 8,000 r.p.m. Can be used with any 4 or 6 cylinder car. **49/6** Plus 3/6 P. & P.

FIXED FREQUENCY SIGNAL GENERATOR

Crystal control in metal case, size 10in. x 6in. x 6in. Incorporating 2 FC13 valves, mains transformer, metal rectifier, choke, indicator lamp, crystal and numerous components. Modulated and unmodulated output sockets. Originally used for I.T.V. frequencies. Brand new. 39/6 + 6/- P & P. A.C. Mains 200/250 volts.



SPECIAL OFFER—Power Supply Kit

To purchasers of "Elegant Seven" parts, incorporating mains transformer etc. AC mains 200/250v output 9v 100 mA 7/6.

THE *"Elegant Seven"*

Combined Portable and Car Radio

- ★ **7-transistor superhet. Output 350 mW.**
- ★ **Two-tone grey wooden cabinet, fitted handle with silver-coloured fittings, Size 12¼in. × 8½in. × 3½in.**
- ★ **Horizontal tuning scale, size 11½in. × 2⅝in. in silver with black lettering.**
- ★ **All stations clearly marked.**
- ★ **Ferrite-rod internal aerial.**

The Radio with the "Star" Features

- ★ **IF 470 kc/s.**
- ★ **Operated from PP9 battery.**
- ★ **Fully comprehensive instructions and point-to-point wiring diagram.**
- ★ **Printed circuit board, back-printed with all component values.**
- ★ **Fully tunable over medium and long waveband.**
- ★ **Car aerial socket.**
- ★ **Full after-sale service.**

4in. SPEAKER. Parts list and circuit diagram **2/6.** FREE with parts.

ONLY

£4 . 19 . 6

PLUS 5/6 POST & PACKING

RADIO AND T.V. COMPONENTS (ACTON) LTD.

.IA, HIGH ST., ACTON, LONDON, W.3.

Goods not despatched outside U.K All enquiries S.A.E. Terms C.W.O.

SHOP HOURS 9 a.m.—6 p.m. EARLY CLOSING WEDNESDAY

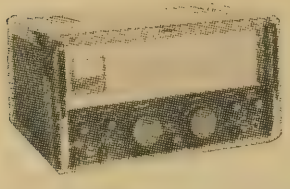
WEBB'S RADIO

for the

NEW EDDYSTONE "EA12"

AMATEUR BANDS RECEIVER

£185 delivered U.K.

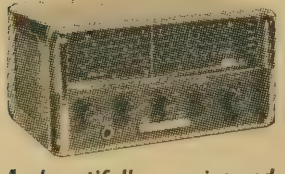


Answers all the problems of Amateur Bands reception. Highly stable—Xtal Control — superb bandspread — internal Xtal Calibrator—switched SSB selection with fine tuning—deep slot filter —impressive "S" meter —two AGC constants— and a host of features DETAILED IN THE BROCHURE, AVAILABLE POST FREE.

You may hear and handle this superb receiver at 14 Soho Street—or try it out at your own home, please contact us for details. BUT WE WARN YOU!—ONCE THE "EA12" IS HANDLED YOU WILL NEVER BE CONTENT WITH ANY OTHER RECEIVER—the "EA12" is literally unique. ● ● ● ● ● ● ● ● ●

● AND THE MAID OF ALL WORK THE

EDDYSTONE "EC10"



£48 delivered U.K.

(Postage abroad £1.10.0 approx)

- COMPACT FOR MOBILE WORK
- HIGH PERFORMANCE FOR THE SHACK
- HANDSOME FOR THE HOME
- RELIABLE FOR THE PROFESSIONAL
- HOME TRIAL ARRANGED

A beautifully engineered communications receiver. Fully transistorized, and powered by six 'U2' torch cells, tunes 550 Kc/s. to 30 Mc/s. in five ranges.

● ALL EDDYSTONE RECEIVERS IN STOCK

WEBB'S RADIO

14 SOHO STREET, OXFORD STREET, LONDON, W.1

Telephone: Gerrard 2089 & 7308 *Cables: CRISWESBO LONDON W.1*

14W W—145 FOR FURTHER DETAILS.

BENTLEY ACOUSTIC CORPORATION LTD.

38 CHALCOT ROAD, CHALK FARM, LONDON, N.W.1

THE VALVE SPECIALISTS *Telephone PRIMROSE 9090*

ALL GOODS LISTED BELOW IN STOCK

OA2	4/6	7R7	12/6	DD41	10/6	EL95	5/6	PY801	6/3	MIDGET	
OB2	6/-	7Y4	5/-	DF66	15/-	EL360	27/-	R10	15/-	SILICON	
OZ4GT	4/3	9BW6	9/6	DF96	5/9	EL820	16/4	R16	29/-	RECTI-	
1A5	5/-	10C1	8/9	DF97	10/-	EL822	18/6	R18	9/6	FIERS	
1A7GT	7/9	10C2	12/3	DH76	3/6	ELL80	20/5	R19	6/6	Mullard	
1C5	5/-	10D2	11/8	DK40	15/6	EM4	17/9	SP41	2/-	BY100	
1D6	9/6	10F1	10/-	DK92	6/9	EM34	11/6	SP61	2/-	Output	
1H5GT	7/9	10F9	9/9	DK96	6/3	EM71	13/6	SU25	27/2	250 v. at ½	
1L4	2/3	10F18	9/9	DL68	15/-	EM80	6/3	T41	9/-	amp.	
1LD5	4/-	10P13	8/3	DL96	5/9	EM81	7/-	TDD4	7/6	No larger	
1LN5	4/6	10P14	11/6	DL810	10/6	EM84	6/9	TH41	13/-	than a shirt	
1N5GT	8/6	12A6	2/3	DM70	5/-	EM85	8/9	TH233	6/9	button.	
1R5	4/-	12AC6	8/6	DY86	6/9	EM87	7/6	TP22	5/-	7/- each	
1S4	5/-	12AD6	9/6	DY87	8/-	EN31	10/-	TP25	5/-	TRAN-	
1S5	3/6	12AE6	8/-	ES0F	24/-	EY51	5/6	TP2620	17/6	SISTORS	
1T4	2/3	12AH8	10/9	ES3F	24/-	EY81	7/3	TY8OF	11/3	AND	
1U4	5/6	12AT6	4/6	ES8CC	10/-	EY83	9/3	U12/14	7/6	DIODES	
1U5	5/3	12AU6	5/9	E180F	19/6	EY84	9/6	U16	15/-	AA129	4/6
2D21	5/6	12AV6	6/6	EA50	1/6	EY86	5/6	U18/20	6/6	AC107	14/6
2X2	3/-	12BA6	5/9	EA76	6/9	EY88	8/9	U19	48/6	AC127	9/6
3A4	3/9	12BE6	4/9	EABC80	5/6	EZ40	5/3	U22	5/9	AD140	25/-
3A5	6/9	12BH7	6/-	EAC91	3/3	EZ41	6/-	U24	12/6	AF102	27/6
3B7	5/-	12E1	16/9	EAF42	7/6	EZ80	3/9	U25	8/3	AF114	11/-
3D6	3/9	12J7GT	7/3	EB34	1/-	EZ81	4/-	U26	7/6	AF115	10/6
3Q4	5/3	12K5	10/-	EB41	4/9	FC4	8/9	U31	6/9	AF116	10/-
3Q5GT	7/-	12K7GT	3/6	EB91	2/3	GZ33	17/6	U33	13/6	AF117	5/6
3S4	4/6	12K8GT	9/-	EBC33	6/-	GZ34	10/-	U35	16/6	AF118	20/-
3V4	5/3	12Q7GT	3/6	EBC41	6/6	GZ37	14/6	U37	29/-	AF124	11/-
5B4GY	8/6	12SA7	6/9	EBC81	5/9	HABC80	2/3	U45	15/6	AF125	10/6
5U4G	4/6	12SC7	4/-	EBF80	5/6	HN309	25/-	U76	4/6	AF126	10/-
5V4G	7/6	12SK7	3/-	EBF83	7/3	HVR2	8/3	U101	19/6	AF127	9/6
5Y3	4/9	12SQ7	3/-	EBF89	6/3	HVR2A	8/9	U191	9/6	BYZ13	11/6
5Z3	7/-	14H7	9/6	EBL21	10/6	KT33C	4/-	U281	8/9	MAT100	7/9
5Z4G	7/-	19AQ5	7/3	EC70	4/9	KT36	29/1	U282	12/3	MAT101	8/6
6A8	5/9	19H1	6/-	EC92	6/6	KT41	7/6	U301	11/3	MAT120	7/9
6AG5	2/6	20D1	10/-	ECC32	4/-	KT44	5/-	U329	9/-	MAT121	8/6
6AG7	5/9	20D2	21/-	ECC34	21/7	KT61	6/9	U403	9/9	OA5	6/-
6AK5	4/9	20F2	11/6	ECC35	5/-	KT63	3/9	U404	6/-	OA10	6/6
6AQ5	5/9	20L1	12/6	ECC40	7/-	KT66	12/3	U801	16/3	OA70	3/-
6AT6	3/9	20P1	12/6	ECC81	3/6	KT88	28/-	U4020	6/6	OA73	3/-
6AU6	5/3	20P3	12/-	ECC82	4/6	KTW61	4/9	UABC80	5/-	OA79	3/-
6AV6	5/6	20P4	13/6	ECC83	4/6	KTW62	5/6	UAF42	7/-	OA81	3/-
6B8G	2/6	20P5	12/3	ECC84	5/6	KTW63	5/6	UB41	10/6	OA85	3/-
6BA6	4/6	25A6G	7/6	ECC85	5/9	MU14	4/6	UBC41	6/3	OA86	4/-
6BG6G	13/6	25L6	4/9	ECC88	8/9	N37	23/3	UBC81	6/3	OA90	3/-
6BE6	4/9	25Z4G	6/6	ECC189	11/6	N78	28/-	UBF80	5/9	OA91	3/-
6BH6	5/3	25Z5	7/3	ECC807	15/-	N108	26/2	UBF89	6/9	OA95	3/6
6BJ6	5/6	27SU	23/3	ECF80	6/-	N339	15/-	UBL21	10/9	OA210	9/6
6BQ7A	7/6	28D7	6/9	ECF82	6/3	PABC80	6/9	UC92	6/3	OA211	13/6
6BR7	8/3	30C1	5/6	ECF86	11/6	PC86	10/3	UCC84	8/9	OC16W	35/-
6BR8	8/-	30C15	9/-	ECF804	24/-	PC88	9/6	UCC85	5/6	OC19	25/-
6BS7	25/-	30C18	10/6	ECH21	9/-	PC95	11/8	UCF80	8/9	OC22	23/-
6BW6	6/9	30F5	5/9	ECH35	6/3	PC97	7/3	UCH21	8/-	OC23	57/-
6BW7	5/-	30FL1	9/3	ECH42	7/6	PCC84	5/6	UCH42	7/-	OC25	12/-
6C5	4/-	30L1	5/6	ECH81	5/9	PCC85	6/9	UCH81	6/6	OC26	25/-
6CD6G	18/-	30L15	9/3	ECH83	6/6	PCC88	10/6	UCL82	7/9	OC28	23/-
6CH6	5/-	30P4	12/3	ECH84	9/6	PCC89	7/9	UCL83	8/6	OC29	25/6
6CW4	24/-	30P12	7/6	ECL80	6/-	PCC189	10/6	UF41	6/9	OC35	9/6
6D3	9/6	30P19	12/3	ECL82	6/3	PCF80	5/6	UF42	4/9	OC36	21/6
6E5	9/6	30PL1	8/6	ECL83	9/6	PCF82	6/3	UF80	6/3	OC41	8/-
6F1	9/6	30PL13	9/6	ECL86	8/9	PCF84	8/6	UF85	6/9	OC42	5/-
6F6G	3/9	30PL14	12/6	EF9	20/6	PCF86	7/9	UF86	9/-	OC43	12/6
6F7	5/-	35A5	14/6	EF22	6/6	PCF801	10/-	UF89	6/-	OC44	8/8
6F13	4/9	35L6GT	6/9	EF36	3/3	PCF802	10/-	UL41	6/9	OC44PM	
6F23	6/3	35W4	4/9	EF37A	6/-	PCL82	6/3	UL44	23/3		11/-
6F24	9/6	35Z3	14/6	EF39	3/9	PCL83	7/9	UL46	8/6	OC45	8/-
6F33	3/6	35Z4GT	4/6	EF40	8/9	PCL84	7/-	UL84	6/-	OC45M	8/-
6J5G	3/-	35Z5GT	5/9	EF41	6/9	PCL85	7/6	UM4	15/2	OC65	22/6
6J6	3/-	50B5	6/6	EF42	4/9	PCL86	8/9	UM34	16/10	OC66	25/-
6J7G	4/6	50C5	6/6	EF50	2/6	PEN45	7/-	UM80	8/3	OC70	6/6
6K7G	1/3	50CD6G	40/9	EF54	3/-	PEN45DD		UR1C	6/6	OC71	3/6
6K8G	3/3	50L6GT	6/3	EF73	5/-		12/-	UU6	9/-	OC72	8/-
6K25	24/-	72	6/6	EF80	3/9	PEN3833	10/3	UU7	7/6	OC73	16/-
6L1	10/-	78	4/9	EF83	9/9	PEN453DD		UU8	11/6	OC74	8/-
6L7GT	4/6	80	5/3	EF85	4/6		10/-	UY1N	10/3	OC75	8/-
6L18	10/-	83	22/6	EF86	6/-	PENDD		UY21	7/3	OC76	8/6
6LD3	6/6	85A2	6/6	EF89	4/-	4020	17/6	UY41	4/6	OC77	12/-
6N7GT	5/-	90AG	67/6	EF91	3/-	PL33	9/	UY85	5/-	OC78	8/-
6P28	11/6	90AV	67/6	EF92	2/6	PL36	8/-	VM84B	12/-	OC81	4/-
6Q7G	4/-	90CG	42/-	EF97	11/8	PL38	16/-	VP4	14/6	OC81D	4/-
6R7G	5/3	90CV	42/-	EF98	10/-	PL81	6/9	VP4B	20/5	OC81M	8/-
6SL7GT	5/3	90C1	16/-	EF183	7/-	PL82	5/3	VP13C	7/-	OC82	10/-
6SN7GT	4/-	150B2	11/9	EF184	7/-	PL83	5/3	VP23	2/6	OC83	6/-
6U4GT	8/6	866A	12/6	EH90	7/-	PL84	5/-	VP133	9/9	OC84	8/-
6U5G	5/-	5763	7/6	EK32	5/9	PL500	15/9	VR105	5/6	OC139	12/-
6V6G	3/9	AZ1	5/9	EL32	3/6	PM84	9/3	VR150	4/9	OC140	19/-
6V6GT	5/6	AZ31	6/6	EL33	6/9	PX4	9/-	W76	3/6	OC170	8/6
6X4	3/9	AZ41	6/6	EL34	8/6	PX25	8/6	W81M	5/9	OC171	9/-
6X5	4/6	B36	4/9	EL36	8/9	PY31	6/-	X41	15/-	OC200	10/6
6/30L2	8/3	BL63	10/6	EL41	7/3	PY32	8/6	X61	6/3	OC201	29/-
7A7	12/6	CCH35	12/6	EL42	7/6	PY33	8/9	X65	5/6	OC202	24/6
7B6	12/6	CV85	14/6	EL81	8/3	PY80	5/-	X66	7/3	OC203	14/-
7B7	7/-	CY31	5/9	EL83	6/9	PY81	4/9	X76M	9/-	OCP71	17/6
7C5	7/3	D15	13/6	EL84	4/6	PY82	4/9	X78	20/6	ORP12	12/6
7C6	6/9	D43	17/9	EL85	7/6	PY83	5/9	X79	27/-	TS2	12/6
7D6	14/6	DAF96	5/9	EL86	7/3	PY88	7/9	Y63	5/-	TS3	15/-
7H7	5/9	DD4	12/6	EL91	2/6	PY800	6/-	Z66	7/3	XA103	15/-

METAL RECTIFIERS. DRM1B 13/-; DRM2B and DRM3B 15/6; LW7 21/-; LW15 26/-; RM0 7/11; RM1 5/3; RM2 6/3; RM3 7/9; RM4 12/9; RM5 17/6; 14A86 17/6; 14A97 19/6; 14A100 23/-; 14A124 26/6; 14A163 35/6; 14B130 31/-; 14B261 11/6; FC101 16/9; 16RC1.1.1.6.1 8/-; FC31 21/-; 16RD 2.2.8.1 11/-; 16 RE 2.1.8.1 8/6; 18RA.1.1.8.1 4/-; 18EA.1.2.8.1 11/-; FC116 6/-; FC124 12/6.

ELECTROLYTICS, Can types:—32 × 32/450 v. 5/9; 50 × 50/350 v. 7/-; 64 × 120/350 v. 8/3; 60 × 250/275 v. 9/6; 100 × 400/275 v. 12/6; 100/275 v. 3/-; 200/275 v. 4/-; 100 × 200/275 v. 9/6; Wire-ended types:—8/450 v. 1/9; 16/450 v. 2/9; 32/450 v. 3/9; 8 × 8/450 v. 3/-; 16 × 16/450 v. 4/-; 32 × 32/350 v. 4/-; 8 × 16/450 v. 3/9; 32/350 v. 3/-.

BRIDGE RECTIFIERS. 12 v./1 amp. 6/6; 12 v./2 amp. 9/9; 12 v./4 amp. 14/6; 12 v./6 amp. 21/9; 6 v./2 amp. 6/6; 6 v./4 amp. 9/9/; 6 v./8 amp. 14/6; 6 v./12 amp. 21/9. Post 1/6 each.

All goods are new, first quality brands only, and subject to maker's full guarantee. We do not handle manufacturers' seconds nor rejects, which are often described as "new and tested" but have a limited and unreliable life.

Terms of business:—Cash with order or C.O.D. only. Post/packing 6d. per item. Orders over £3 post/packing free. C.O.D. 3/6 extra. All orders cleared on day of receipt. and C.O.D. orders by telephone accepted for immediate despatch until 3.30 p.m. Any parcel insured against damage in transit for only 6d. extra. Callers welcome Mon.-Fri., 8.30-5.30, Sats. 8.30-1 p.m. Complete catalogue of valves and components, with conditions of sale, price 6d.

DON'T MISS THESE BARGAINS

Transistor ferrite rod aerial with medium and long wave coils with circuit, **7/6**.
Oscillator Coil and set of 3 I.F. transformers for transistor set with circuit, **12/6**.
Tuning Condenser to suit, air-spaced with trimmers, **9/-**.
Ditto but sub. min. **7 cm.** **10/-** the set two-gang condensers to suit **8/6** (request sub. min. circuit).
Midget 3in. P.M. Loudspeaker, 3 ohm, **12/6**, 80 ohm, **13/6**.
Midget 208 pF + 176 pF two-gang Tuning Condenser with trimmers for transistor set. Price **9/-**.
Push-Pull Transformer. Sub-miniature, **8/6**.
.0005 mfd. Single Tuning Condenser. Solid dielectric ¼in. **spindle for transistor** or Crystal set, with **spindle tapped 6 BA., 2/6.**
46 Sets (Receiver/Transmitter pack set). Unused sets complete except for crystals. **19/6**. Post 3/-.
Battery Charger Kit. Comprises 5 amp. transformer, 5 amp. rectifier, metal case and meter to charge 6 or 12 volt batteries up to 5 amps. With variable charge rate, **39/6** each. 3/6 post & insurance.
Mains Transformer. 250-0-250 at 80 mA. 6.3 volts 5 a. (normal mains input), **12/6**. each. Carr. 2/6.
Output Transformer. Standard pentode matching type, **4/6** each; **48/-** per doz.
Side Switch. Sub-miniature but dpdt, **2/-**; **18/-** doz.
T.C.C. or Dubilier Tubular Condensers.

.5 mf.	500v.	10/- doz.
.25 mf.	500v.	7/6 doz.
.25 mf.	350v.	6/- doz.
.05 mf.	500v.	5/- doz.
.01 mf.	500v.	4/- doz.
.0001 mf.	1000v.	5/- doz.
.001	1000v.	6/- doz.
.002	1000v.	7/6 doz.
.005	1000v.	9/- doz.
.02	750v.	8/6 doz.
.01	1000v.	10/- doz.

Battery Charger Rectifier, Selenium 12-15 v. 5 amp. **9/6**.
Metal Chassis. Punched for Mullard 510 Amplifier, complete with inner screening sections and stove enamelled. **12/6** set.
Twin Twisted Lighting Flex. Equivalent 14/36, rubber insulated, cotton covered, **12/6** per 100 yard coil.
Unbreakable Mains Lead. Type of lead fitted to electric razors makes fine lead for test meters and any other devices where subject to continuous bending. Twin figure eight construction, soft cream P.V.C. covered. Normally costs 2/- per yard. Three 6ft. leads for **2/-**.
Filament Transformers, 6.3 v., 1½ amp. **6/6**.
Neon Lamp —midget wire ended, ideal mains tester, etc. **2/-**. Ex-Govt. **1/6**.
Philips Trimmers. 0-30 pF. **1/-** each; **9/-** doz.
Heavy Duty Test Prods—red and black with plug-in lead attachments, **6/6**.
Low Resistance Headphones. Ideal crystal sets, etc. **7/6**, plus 2/6.
Cold Cathode Valve CV 413, Voltage regulator or trigger switch—unused but ex-equipment. **2/-** each.
Tag Panels. Ideal for construction, experimental circuits, etc., 3 of each of 12 different types, **5/-**. Post 1/6.
Slydlock Panel Mounting Fuses, with carrier, 5 amps. **2/-**; each; 15 amp. **2/6** each.
.1 mfd. 350 v. Small tubular metal-cased condenser made by Dubilier, **2/6** doz.
Toggle Switch. Standard metal body, type with round dolly, fixing ring and on/off indicating plate. **1/3**; or **12/-** doz.
Metal Rectifier. 250 v. 60-80 milliamps, ideal for mains set or instrument or to replace that expensive valve, **4/6**.
Long, Medium and Short Wave Coil Pack. An exceptionally well made coil pack which covers the standard long, medium and short wavebands for 465 kc/s. I.F. complete with diagram of connection, **14/6**.
Piano Key Type Switches. 3 key type **3/-**, 4 key type **3/9**, 5 key type **4/6**, post and packing 1/- regardless of number ordered.
500 MW Amplifier. Uses 3 transistors, 2 of which are in Glass B push pull for battery economy. Ideal little unit for baby alarm, record player, intercom, etc., etc. **19/6**. Speaker **12/6** extra.
Electrolitic Condenser—Bargain. Sub-miniature type 50 mfd. 6 v. made by T.C.C. **7/6** per dozen (minimum quantity supplied).
Transistor Set Cases. Finished in two tone with handle and back. Size 10½ × 7½ × 3 **15/-** each, plus 2/6 carriage and insurance.

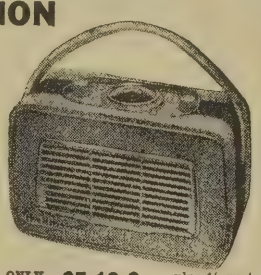
SPEAKER BARGAIN

12in. High fidelity loudspeaker, High flux permanent magnet type with standard 3 ohm speech coil. Will handle up to 12 watts. Brand new, by famous maker. Price **27/6**, plus 3/6 post and insurance.

Where postage is not definitely stated add 2/- to all orders under £3.

GOOD COMPANION

Mark III B



The 6-transistor set with the 8-transistor performance.

Incorporating all the latest refinements. Anyone who can solder can make it.

Many thousands already in use all over the country.

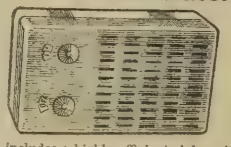
Full coverage of Long and Medium wavebands.

Fine looking cabinet, size 11 × 8 × 3in. Q.P.P. output approx. 750 MW. Excellent reception of difficult stations like 208.

Variable feedback gives excellent tone.

ONLY **£5.19.6** plus 4/- post and insurance.

OUR BARGAIN OF THE YEAR



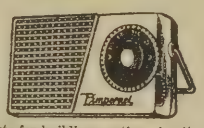
A Complete kit of parts to build this 6-transistor 2 wave superhet receiver at only 39/6, plus 3/6 post and ins.

"CORONET" Mk. IV

It fully covers the medium-wave band and that part of the long-wave band to bring in B.B.C. Light. The circuit includes a highly efficient slab aerial and 2½" P.M. speaker. Overall size approximately 4½ × 2½ × 1½in. Supplied complete with carrying case.

THIS MONTH'S SNIP

£5.10.0 RADIO for only 37/6



Originally sold at £5/10/- we now offer the "Pimpernel" 5 Transistor Pocket Radio at only **37/6**. The sets are complete but are "line rejects" so there will be some small faults to find. Alternatively, of course, you can use the parts for building another circuit. Components are all new and unused, and their retail value, even at today's lowered price, is over £4. Parts you will get include:—

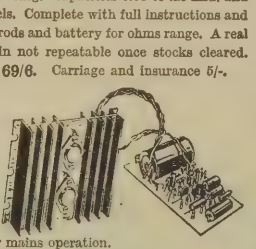
Jackson "00" Tuning Condenser	9/-
Plessey Driver Transformer	8/6
Goodman's or Plessey 3in. speaker	12/6
Morganite Volume Control with switch	4/6
Philco RF Transistor	12/6
S.T.C. matched output transistors and driver	15/-
Plastic Case with carrying handle	7/6
5 Electrolitic Condensers	7/6
10 Resistors	3/6
Ferrite Aerial	5/-

and printed circuit board, trimmers, battery connectors, R.F. choke, etc., etc. All this fine equipment offered this month at only **37/6** plus 2/6 post and insurance.

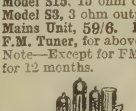
MULTI-METER BARGAIN

Model number EP10K. Extra wide scale fitted corner-wise for compactness, extra accurate as it uses 1% components. Sensitivity 10,000 ohms per volt. A.C. and D.C. ranges. D.C. voltage up to 1.2kV in 5 ranges A.C. voltage up to 1.2kV 5 ranges. D.C. current up to 300mA 3 ranges. Resistance up to 2 meg. Capacities 0.05 to .15 mfd. and decibels. Complete with full instructions and test prods and battery for ohms range. A real bargain not repeatable once stocks cleared. Price **69/6**. Carriage and insurance 5/-.

THE STRAIGHT LINE AMPLIFIER



We call this the straight line amplifier because it is virtually distortionless, even at 10 watts. This is achieved by the careful use of feed back, choice of components and transformerless design. Sensitivity is 100 mV. from 10 K. source. Push-pull output. For battery or mains operation.
Model S15. 15 ohm output, **£5/19/6**, plus 2/6 post and insurance.
Model S3, 3 ohm output, **£5/10/-**, plus 2/6 post and insurance.
Mains Unit, 59/6. Pre-Amplifier, mono **65/-**; stereo, **£10/19/6**.
F.M. Tuner, for above, **£7/19/6**.
Note—Except for FM Tuner all above are made up ready for use, fully guaranteed for 12 months.



AMPLIFIER FOR PORTABLE PLAYER

—uses three valves, has good quality output and draws power through mains transformer for safety. Real bargain at **19/6**, plus 2/6 post (less valves).

MAINS POWER PACK

MAINS POWER PACK designed to operate transistor sets and amplifiers. **Adjustable output 6 v.—9 to 12 volts for up to 500 mA. (class B working). Takes the place of any of the following batteries. PR1, PP3, PP4, PP6, PP7, PP9, and others.** Kit comprises: mains transformer-rectifier, smoothing and load resistor, 5,000 and 500 mfd. condensers, zener diode and instructions. Real snip at only **14/6**, plus 2/6 post.

INFRA RED HEATERS

Make up one of these latest type heaters. Ideal for bathroom, etc., They are simple to make from our easy-to-follow instructions—uses silica enclosed elements designed for the correct infra-red wavelength (3 microns). Price for 750 watt element and metal casing as illustrated, **19/6**, plus 2/6 post and ins.

BRAYHEAD TURRET TUNER

Complete with Band 1 and Band 3 coils. New but removed from unused equipment. Less valves, **15/- each,** or with valves **25/-** each. Post 2/6. Knobs **3/6** extra.

Waterproof Heater Wire

16 yd. length. 70 watts. Self regulating temperature control, **10/-** post free.

Fluorescent Light Kits

For pelmet lighting, etc. Kit consists of: Super silent choke; 2 chrome clips to hold tube; 2 bi-pin holders for tube and starter with a starter holder. Kit A for 80 watt tube at **27/6**. Kit B for 40 watt tube at **19/6**. Kit C for 2 × 2ft. 20 w. lamp **25/-**. Kit D for 1 × 2ft. 20 w. lamp **18/6**. Post and insurance 2/6 per Kit.

Cabinet Snip

This fine cabinet as illustrated but less control knobs is available this month at a special snip price of **12/6**, plus 3/6 post and insurance. Size is 3¾in. × 9in. × 4in. and it is nicely covered in two - tone I. C. I. fabric.

SIEMENS HIGH SPEED RELAY

Twin 250 ohm coils adjustable tension change over contacts—plat. points **7/6**, post 1/-.

FIVE CORE CABLE

Ideal for switching circuits, intercoms., P.A. runs, etc., each core flex copper with rubber insulation cores covered overall in tough rubber or P.V.C. **9d.** per yd. or 30 yds. length **15/-** plus 5/- post.

MAKING A FAN HEATER

Miniature motor 2¾in. long × 1¼in. diameter, laminated poles. Operates off 20-30 v. D.C. Original cost at least £3 each. **8/6** plus 1/6 postage and insurance. Mains model **9/6** plus 2/6 postage and insurance.

ELECTRIC BLANKET SPARES
We carry a good stock of elements, thermostats and switches etc. for Electric Blankets. Send S.A.E. for list.

THERMOSTATS

Type "A" 15 amp for controlling room heaters, greenhouse, airing cupboard. Has spindle for pointer knob, quickly adjustable from 30-80°F., **9/6** + 1/- post. Suitable box for wall mounting, **5/-**, p. & p. 1/-.
Type "B" 15 amp. This is a 17in. long rod type made by the famous Sunvic Co. Spindle adjusts this from 50-550°F. Internal Screw alters the setting so this could be adjustable over 30° to 1000°F. Suitable for controlling furnace, oven, kiln, immersion heater or to make flame-stat or fire alarm. **8/6**, + 2/6 post and insurance.
Type "C" is a small porcelain thermostat as fitted to electric blankets etc. 1½ amp. setting adjustable by screw through side. **3/6**, p. & p. 6d.
Type "D". We call this the Ice-stat as it cuts in and out at around freezing point 2/3 amps. Has many uses, one of which would be to keep the loft pipes from freezing. if a length of our blanket wire (16 yds. **10/-**) is wound around the pipes. **7/6**, p. & p. 1/-.
Type "E". This is a standard refrigerator thermostat. Spindle adjustments over normal refrigerator temperatures, **7/6**. + 1/- post.

ELECTRONICS (CROYDON) LIMITED

266 LONDON ROAD, WEST CROYDON, SURREY
***Post orders to:* 43 SILVERDALE ROAD, EASTBOURNE, SUSSEX**

TRANSISTORS

AA120 .... 4/6	OC42 .... 6/6	SETS OF TRANSISTORS	
AC107 ....14/6	OC43 .... 5/6	Set 1.	
AC113 .... 8/-	OC44 .... 5/9	Comprising OC44	
AC114 .... 8/-	OC44M 8/9	2 × OC45 matched pair and	
AC154 .... 8/-	OC45 .... 5/9	Driver OC81	
AC155 .... 6/6	OC45M 8/-	set 20/-	
AC156 .... 8/-	OC70 .... 6/6		
AC157 ....10/6	OC71 .... 4/3	Set 2.	
AC165 ....10/-	OC72 .... 6/-	Comprising OC81	
AC166 ....10/-	2-OC72 ..16/-	Driver, matched	
AC167 ....12/-	OC74 .... 6/6	pair OC81	
AC168 ....15/-	OC75 .... 6/-	set 12/6	
AC169 ....16/6	OC78 .... 8/-		
AD140 ....25/-	OC81 .... 5/9		
AF102 ....27/6	OC81M 8/-	DIODES	
AF114 ....11/-	OC82 ....10/-	AA129 .... 4/6	
AF115 ....10/6	OC83 .... 4/6	BY100 ....11/6	
AF116 ....10/-	OC139 .... 9/-	OA70 .... 3/-	
AF117 .... 9/6	OC169 .... 6/6	OA79 .... 3/-	
AF118 ....20/-	OC170 .... 9/6	OA81 .... 2/3	
AF124 ....10/-	OC171 ....10/6	OA90 .... 3/-	
AF125 ....10/6	XA103 .... 3/6	OA91 .... 3/-	
AF126 ....10/-	XA104 .... 3/6	OA95 .... 3/6	
AF127 .... 9/6	AE1, BTH.	OA210 .... 9/6	
BA116 .... 9/-	GT40 .... 3/6	GEX34 .. 4/-	
BY100 .... 7/6	Yellow Spot 1/6	GEX35 .. 4/-	
BY105 ....13/-	Green Spot 1/6	GEX36 ..10/-	
BY114 .... 7/6	White Spot 2/-		
OC16W ..35/-	Red Spot .. 2/-	ZENIE DIODE	
OC19 ....25/-	Package Set 1	OAZ207 .. 8/-	
OC26 ....25/-	XB103D and 2X	Transistor	
OC35 ....15.6	XC101T 8/6	Holders .. 1/6	

CATALOGUE

Our latest 1964/65 Catalogue is now available. Copies have been sent to many of our regular customers. If you have not received your copy please drop us a card. Please send 1/- in stamps. Wholesale terms to Schools, Universities and Business Houses. Trade Catalogue now available. Please apply on business letter heading.

TERMS: Cash with Order or C.O.D. Postage and Packing Charges extra. Single valves 9d., Minimum Parcel Post charges 2/-. Please include sufficient postage with your order. Minimum C.O.D. fees and postage 3/6. These Postal Rates apply to U.K. only. For full terms of business see inside cover of catalogue. Personal shoppers 9 a.m. to 5 p.m. Mon. to Friday, Saturday 10 a.m. to 1 p.m.

ALPHA
RADIO SUPPLY CO.
103 LEEDS TERRACE
WINTOUN STREET
LEEDS 7

RECORD PLAYER AND TAPE DECK UNITS

B.S.R. Monarch UA14, £6.6.0.
Stereo Version, £6.17.6.
B.S.R. Monarch UA15, £6.19.6.
Stereo Version, £7.15.0.
B.S.R. Monarch TU12, £3.10.0.
Battery version of above, £3.17.6.
B.S.R. Monarch GU7, £3.17.6.
Battery version of above, £4.4.0.
B.S.R. Monarch TD2 Tapedeck, 2 track, £8.8.0.
4 track version of above, £9.9.0.
Garrard Autoslim, £6.19.6.
B.S.R. Monarch TD10 Tapedeck, 2 track, £9.9.0.
4 track version of above, £10.10.0.
Garrard Autoslim De Luxe Model AT6, £11.5.0.

MULTI-RANGE TESTMETERS

Eagle TK20A	£2 9 6
Eagle EP10K	£4 9 6
Eagle EP20K	£4 19 6
Eagle EP30K	£6 19 6
Leather Case for above	19 6
Eagle EP50K	£9 19 6
Leather Case for above	£1 9 6
Caby M1 —	£2 14 0
Caby A10 —	£4 17 6
Caby B40 —	£6 2 6
Altham 200H	£5 5 0
Taylor 127A	£10 10 0
Leather case for above	£2 5 0

GOODMANS HIGH QUALITY FIDELITY LOUDSPEAKER UNITS

AXIETTE 8
Frequency range 40-15,000 c/s., rated 6 watts, resonance 65 c/s., impedance 15/16 ohms. £5.5.7.

AXIOM 10
Frequency range 40-15,000 c/s., rated 10 watts, resonance 45 c/s., impedance 15/16 ohms. £6.5.11.

AXIOM 201
Twin diaphragm 12in. unit. Frequency range 30-16,000 c/s., rated 15 watts, resonance 35 c/s., impedance 15/16 ohms. £10.17.4.

AXIOM 301
12in. Twin diaphragm loudspeaker. Frequency range 30-16,000 c/s., rated 20 watts, resonance 35 c/s., impedance 15/16 ohms. £15.4.6.

AUDIOM 81
15in., 25 watt, 15 ohm, available in two versions. Audiom 81 Bass-Audiom 81 Standard. £25 each.

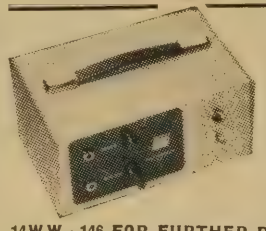
AUDIOM 51
12in. rigid die-cast chassis. Bass unit rated 15 watt. £9.2.8.

AUDIOM 61B
12in. 20 watts. £14.7.8.

ELEGANZIA HIGH FIDELITY LOUDSPEAKER SYSTEM
Dimensions 27in. high × 20in. wide × 6½in. deep. Frequency range 35 c/s. to 15,000 c/s. Power handling capacity 15 watts, impedance 15/16 ohms. £27.10.0.

LATEST GOODMAN MAXIMUM LOUDSPEAKER SYSTEM
Available in walnut or teak £17.10.6.

HORN LOADED PRESSURE UNITS
High Frequency TREBAX 100-25 watts £6.10.2.
High Frequency TREBAX/20XL £7.7.0.
Mid-Frequency MIDAX 650-25 watts £9.19.6.
COMPONENTS Crossover XO/5000 £2.0.11.
Crossover XO/950/5000 £7.7.6.



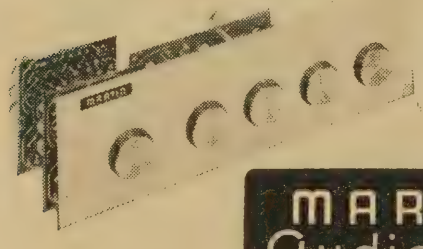
TRANSISTOR AMPLIFIER T615 EKE

15WT.—Two mixing and separately controlled inputs. Description: P/Pull Class B.P.A. set with inputs for microphone and gram. Operated from 12v. battery. Output 15 watts Peak into 15 ohm load. Fully mixing inputs. Pre-amplifier stage being of such sensitivity that practically any make or type of microphone may be used. Specification: Mic Sensitivity 2 m.v. (600 ohm). Gram sensitivity 200 m.v. (100K), for full output. Frequency response ±3 d.b. 60 c.p.s. to 7 Kc/s. Harmonic distortion 1% at 10 watts. Current Consumption: Quiescene 270 m.a. Average Speech Music 1.3/1.5 amps. Size: 9in. × 5½in. × 6½in. Weight: 6¾ lbs.

Special Features: Sensible size permits generous heat sink which is 10 swg. aluminium and occupies whole of roof area. Accent is upon reliability, even to extent of hand-made wire-wound resistors. Useful output even when worked from car battery down to 10v., £16.10.0.

14WW—146 FOR FURTHER DETAILS.

FROM PRE-AMP TO 20w HI-FI STEREO ASSEMBLY



BY BUILDING WITH

MARTIN Audiokits

This unique system enables the constructor to start with a basic assembly of his own choice and to go on adding Audiokit Units, until ultimately he has a 20-watt hi-fi stereo assembly with tone controls, 5 stage selector, etc. Further designs will make Martin hi-fi even more versatile whilst retaining equipment built so far. ANYONE CAN ASSEMBLE AUDIOKITS WITH ASSURED SUCCESS. Leaflet shows how they save money, too.

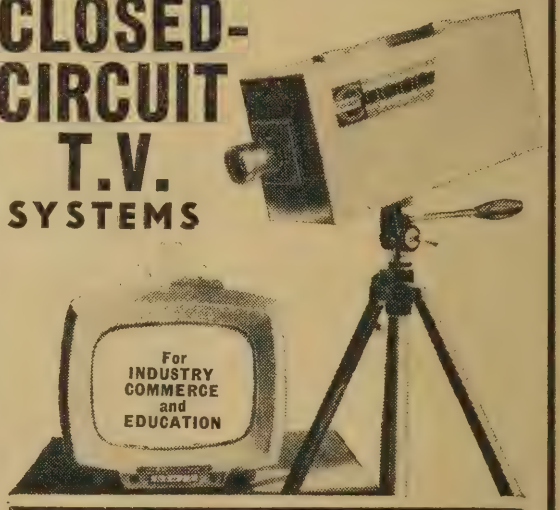
FULLY TRANSISTORISED
●
SUPERB QUALITY
●
SAVE £££s
●
GUARANTEED

SEND COUPON FOR LEAFLET SHOWING COMPLETE RANGE

MARTIN ELECTRONICS LTD., 155, HIGH ST., BRENTFORD, MIDDLESEX *Phone: ISL 1161/2*
Details of all Martin Audiokits, please.
NAME .....
ADDRESS .....
..... WWII

14WW—147 FOR FURTHER DETAILS.

CLOSED-CIRCUIT T.V. SYSTEMS



EQUIPMENT ALSO AVAILABLE FOR HIRE

including Remote-Control Pan/Tilts and 'Zoom' Lenses, Radio-Mikes, Walkie-Talkies, etc.

"THE MIDLANDS LEADING SPECIALISTS IN AUDIO AND VISUAL COMMUNICATION SYSTEMS"

HORNTON'S ELECTRONICS
LOMBARD HOUSE, GT. CHARLES STREET, BIRMINGHAM, 3
Tel.: CEN 6283 or MID 0972

VALVES

Brand new, individually packed and guaranteed

AC/HL 4/6	DL9 .. 5/9	EF74 .. 4/-	HL23 6/-	PL83 .. 5/-	U25 ..11/-	1LH4 4/-	6AM5 2/6	6N7G 5/9	12SJ7 5/-	307A .. 5/6	C.R. Tubes
ACP4 6/-	DL96 5/6	EF80 .. 5/-	HL23DD	PL84 .. 5/-	U27 .. 8/-	1N21B 5/-	6AM6 4/-	6Q7G 6/-	12SK7GT	313C ..25/-	
AC6PEN5/-	DL810 8/-	EF85 .. 4/6		PM24A 5/-	U52 .. 5/-	1N43 4/-	6AQ5 7/-	6R7 .. 5/6		357A ..70/-	CV1596
AL60 5/-	DL819 15/-	EF86 .. 6/-	HL41 4/-	PT15 ..10/-	UABC80 4/6	1N70 .. 4/-	6AQ5W 9/-	6SA7 .. 7/-	12SN7GT	368A .. 5/-	(O9J) 55/-
AR8 .. 5/-	E80F 23/-	EF89 .. 3/9	HVR2 9/-	PT25H 7/6	UBC41 6/-	1R4 .. 5/-	6A86 4/-	6SA7GT 6/6	5/9	393A .. 15/-	E4504/B/16
ARP .. 3/6	E1148 2/6	EF91 .. 2/9	K3A ..30/-	PT25M 7/6	UBF80 5/6	1R5 .. 3/6	6A86W 9/-	6SC7 .. 7/-	12SR7 5/-	446A .. 8/-	28/-
ARP3 3/-	E1266 50/-	EF92 .. 2/-	KT8C 22/-	PX4 ..14/-	UBF89 6/6	1S4 .. 5/-	6AT6 .. 3/6	6SC7GT 5/-	12Y4 .. 2/-	703A ..30/-	VCR97 28/-
ARP12 2/6	E1415 30/-	EF95 .. 5/-	KT22 8/-	PX25 9/-	UBL21 11/-	1S5 .. 4/6	6AU6 7/-	6SD7 .. 5/-	14L7 .. 7/-	705A ..10/-	VCR138
ARP21 7/-	E1924 12/6	EF183 8/-	KT33C 6/-	PY32 9/6	UCC85 6/6	1T4 .. 2/-	6AX4 8/-	6SF5GT 5/6	15D2 .. 6/-	715B ..60/-	30/-
ARP24 3/6	EA50 1/-	EF184 8/-	KT44 5/9	PY33 8/6	UCH42 6/6	2A3 .. 5/-	6B4G 8/-	6SH7 .. 3/-	19E2 15/-	717A .. 3/-	VCR138A
ARP34 4/-	EA73 7/-	EH71 300/-	KT63 4/-	PY80 5/6	UCH81 6/-	2A5 .. 6/-	6B7 .. 6/-	6SJ7 .. 5/-	19G3 ..10/-	724A ..15/-	40/-
ARTP1 6/-	EABC80 5/-	EL32 .. 3/9	KT66 12/9	PY81 5/6	UCL82 8/-	2B26 .. 8/-	6B8G 2/6	6SJ7GT 5/6	19G6 .. 9/-	801 .. 6/-	VCR139A
ATP4 2/3	EAC91 3/6	EL34 .. 8/-	KT67 15/-	PY82 5/-	UCL83 10/-	2C26 .. 7/-	6BA6 .. 4/-	6SJ7Y 6/6	19G7 ..5/-	803 .. 22/6	35/-
ATP7 5/6	EAF42 8/-	EL35 .. 5/-	KT76 8/6	PY83 6/-	UF41 7/6	2C26A 3/-	6BE6 .. 4/3	6SK7 .. 4/6	19H1 6/-	805 ..30/-	VCR517B
AU7 55/-	EB34 1/6	EL38 ..17/6	KT88 18/-	PY800 6/6	UL41 6/-	2C34 .. 2/6	6BJ7 7/-	6SL7GT 5/6	19M1 .. 5/-	807BR 7/-	40/-
BL63 10/-	EB91 3/-	EL41 .. 7/-	KTW61 4/6	PZ1-35 9/-	UL84 5/6	2C43 42/6	6BR7 9/-	6SN7 .. 3/6	20P4 ..13/-	807AM 7/6	VCR517C
BS4 .. 8/-	EBC33 6/-	EL42 .. 8/-	KTW63 2/-	PZ1-75 12/-	UU5 7/-	2C45 22/6	6BW6 9/-	6SQ7 .. 6/-	21B6 .. 9/-	808 .. 8/-	40/-
B85 20/-	EBC41 6/-	EL50 .. 8/-	KTZ41 6/-	QP21 .. 6/-	UU9 .. 8/6	2C46 ..30/-	6C4 .. 2/-	6SS7 .. 2/-	25L6GT 5/6	813 .. 63/-	
B884 47/6	EBC81 5/-	EL81 .. 8/-	KTZ63 5/-	QP25 .. 5/-	UY21 7/6	2C51 ..12/-	6C5G 2/6	6U4GT 9/6	25Y5 6/-	815 ..35/-	3FP7 45/-
B2134 16/-	EBF80 5/-	EL82 .. 6/3	LP2 .. 10/-	QP230 5/-	UY41 4/-	2D21 .. 5/-	6C5GT 6/-	6V6G .. 5/-	25Z4G 6/6	829A ..30/-	5CP1 30/-
BT19 25/-	EBF83 7/6	EL84 .. 5/-	L63 .. 5/-	Q8150/15	UY85 5/-	2X2 .. 3/-	6C6 .. 4/-	6V6GT 5/6	25Z5 .. 7/6	829B ..50/-	5FP7A 12/-
BT35 25/-	EBF89 6/9	EL85 .. 8/-	M8100 9/-	10/-	V1120 4/-	3A4 .. 4/-	6C6G .. 3/-	6V6M 8/-	25Z6GT 8/6	830B .. 4/-	
BT45 150/-	EC52 4/-	EL91 .. 4/6	M8142 12/-	Q895/10 5/6	V1507 5/-	3A/108A	6C8G .. 3/-	6X4 .. 3/6	28D7 .. 6/-	832A ..45/-	Photo
BT83 35/-	EC53 12/6	EL95 .. 5/-	M8190 5/-	Q81202 8/-	V1924 20/-	20/-	6CH6 .. 4/6	6X5G 5/-	30 .... 5/-	832 ..15/-	Tubes
CC3L .. 2/-	EC70 .. 4/-	EM30 6/-	MH4 .. 5/-	QV04/7 8/-	V2023 13/6	3A146J 35/-	6C21 80/-	6X5GT 5/3	30C15 9/6	837 .. 9/-	
CL33 .. 9/-	EC90 20/-	EM81 7/6	MHLD6 10/-	R3 .. 8/-	VMP4G 12/-	3A/167M	6D6 .. 3/-	6Y6G 6/-	30F5 8/6	843 .. 5/-	CMG8 5/-
CV71 .. 3/-	EC91 3/-	EM84 6/3	ML6 .. 6/-	RG4/1250	VP23 .. 3/-	25/-	6E5 .. 6/-	6-30L2 10/-	30FL1 10/6	860 ..10/-	GS16 12/6
CV77 .. 6/-	ECC81 4/-	EM85 9/-	N108 3/-	60/-	VP133 9/-	3D6 .. 4/-	6F5G .. 5/3	6Z4 .. 5/-	30P19 12/-	866A ..14/-	931A 55/-
CV102 1/-	ECC82 5/-	EN31 10/-	NE17 .. 7/-	RK72 6/-	VR99 8/-	3B7 .. 5/-	6F5GT 5/9	7B7 .. 7/6	30PL1 8/-	884 ..10/-	K301 £4
CV103 4/-	ECC83 6/-	ENGT2 10/-	NGT2 10/-	S130P 15/-	VR105/30	3B24 .. 5/-	6F6G .. 4/-	7C5 .. 10/-	35L6GT 7/-	954 .. 4/6	6097C 350/-
CV4014 7/-	ECC84 5/6	EY51 5/6	OB3 .. 7/-	S130 12/6	5/-	3B28 ..15/-	6F7 .. 6/-	7C6 .. 7/-	35T 17/6	955 .. 2/6	
CV4015 5/-	ECC85 6/6	EY86 5/6	OC3 .. 5/-	SP2 .. 8/6	VR130/30	3B24 .. 50/-	6F8G .. 6/-	7C7 .. 6/-	35W4 5/-	956 .. 2/-	Special
CV4025 10/-	ECC91 4/-	EY91 3/-	OD3 .. 5/-	SP41 .. 1/6	W119 8/-	3E29 ..50/-	6F12 .. 4/6	7H7 .. 7/3	35Z3 .. 8/-	957 .. 5/-	Valves
CV4046 40/-	ECF80 5/6	EZ40 5/-	OZ4 .. 4/-	SP61 .. 1/6	X66 .. 7/6	3Q5GT 7/6	6F13 .. 5/-	7Q7 .. 7/-	35Z4GT 6/-	958A .. 4/-	ACT6 £8
CY31 .. 5/6	ECF82 7/-	EZ41 6/6	OZ4A 5/-	SP210 3/6	X118 8/-	3S4 .. 4/-	6F23 .. 4/-	7V7 .. 5/-	35Z5GT 6/-	1612 .. 5/-	ACT9 £12
D1 .. 1/6	ECH42 8/-	EZ80 .. 5/6	PC84 5/-	STV280/40	X145 8/-	3V4 .. 5/9	6F33 .. 3/-	7Z4 .. 4/6	38 .... 4/-	1616 .. 3/-	ESU77 £10
D41 .. 3/3	ECH81 5/-	EZ81 .. 3/6	PCC85 7/-	12/6	YF .. 1/-	4C27 35/-	6G6G .. 2/6	8D2 .. 2/6	41MP .. 4/-	1619 .. 5/-	K301 £4
D61 .. 6/-	ECH83 7/6	F/6067 5/-	PCC89 7/6	STV70/80	Y63 .. 5/-	4D1 .. 4/-	6G6M .. 1/6	9D2 .. 8/-	44A/16ON	1622 ..12/-	417A 30/-
D77 .. 3/3	ECL80 5/6	F/6061 5/-	PCF80 5/-	8/-	Y65 .. 4/-	5A173G 5/-	6H1 .. 6/-	9D6 .. 3/6	11E3 37/6	1625 .. 6/-	3J/92 F
DA30 12/6	ECL82 7/6	F/6063 4/-	PCF82 6/6	SU2150A	Y66 .. 8/-	5A174G 5/-	6H6M ..1/6	11E3 37/6	30/-	1626 .. 3/-	£37/10/0
DA60 75/-	ECL83 10/-	FW4/5006/6	PCF84 5/-	10/-	Z21 .. 6/-	5R4GY 9/-	6J4 .. 9/-	12A6 2/6	2158G 6/-	1629 .. 4/6	714AY £4
DAF96 6/-	ECL86 10/-	FW4/8008/6	PCL81 9/-	T41 .. 6/6	Z800U 20/-	5T4 .. 7/-	6J4WA 10/-	12AH7 5/-	50L6GT 8/-	2051 .. 5/-	723A/B 50/-
DD41 4/-	EF34 .. 2/6	G1/236G 9/-	PCL82 6/-	TP22 .. 5/-	Z801U 10/-	5U4G 4/6	6J5 .. 3/6	12AH8 11/-	53A .. 7/6	2051 .. 5/-	725A 30/-
DET5 8/-	EF36 .. 3/6	G1/371K 6/-	PCL83 8/3	TP25 ..15/-	1A3 .. 3/-	5V4G 8/-	6J5G .. 2/-	12AT7 4/-	57 .... 6/-	4043C 13/6	726A 19/-
DET20 2/-	EF37 .. 7/-	19/-	PCL84 7/-	TT11 .. 5/-	1A5GT 5/-	5X4G .. 8/6	6J6 .. 3/6	12AU7 5/-	58 .... 6/-	4063 .. 8/-	2J54 £3
DET25 15/-	EF39 .. 4/-	G50/2G 5/-	PCL86 9/-	TT15 ..85/-	1B22 ..30/-	5Y3G 4/-	6J6W 6/-	12AU7 5/-	59 .... 6/-	4313C 30/-	417A 30/-
DF73 5/-	EF40 .. 8/-	GU50 25/-	PEN25 4/6	TTR31 45/-	1C5GT 6/-	5Y3GT 5/-	6J7G 5/-	12AX7 6/-	5704 .. 9/-	5726 .. 6/-	3J/92 F
DF91 3/-	EF41 .. 6/-	GZ32 10/-	PEN46 3/-	TZ0320 4/-	LD8GT 6/-	5Y3WGTB	6K6GT 5/6	12AY7 10/-	75 .... 5/6	6064 .. 7/-	£37/10/0
DF92 3/-	EF50 .. 2/6	GZ34 10/-	PEN220A	TZ20 ..16/-	1E7G ..7/6	6A7 5/-	6K7G 2/-	12BA6 5/6	76 .... 5/-	6065 .. 6/-	714AY £4
DF96 6/-	EF52 .. 6/-	H63 .. 7/-	3/-	TZ40 ..30/-	1F2 .. 3/-	6AK5 5/-	6K7GT 4/9	12BE6 7/-	77 .... 6/-	6080 ..22/-	723A/B 50/-
DK92 6/6	EF55 .. 8/-	HK54 22/6	PL36 .. 7/6	U31 8/-	1G6GT 6/-	6AK6 6/-	6K8G 3/-	12BH7 7/-	78 .... 5/-	7193 .. 1/9	725A 30/-
DK96 5/6	EF71 .. 7/6	HL133DD	PL38 ..16/-	U12/14 8/-	1L4 .. 2/6	6AK7 6/-	6K8GT 8/6	12C8 3/-	80 .... 5/6	7475 .. 2/-	726A 19/-
DL92 5/-	EF72 .. 5/-	10/-	PL81 .. 7/-	U17 .. 5/-	1LA6 .. 6/-	6AL5 .. 3/-	6K8M 8/6	12H6 .. 2/-	81 .... 9/-	8013A 25/-	
DL93 6/-	EF83 .. 4/6	HL2K 2/6	PL82 .. 5/-	U18 .. 6/-	1LC6 .. 7/-	6AL5W 7/-	6K8MG 10/-	12J5GT 2/6	82 .... 8/-	8020 .. 8/-	Transistors
							6L5G 6/-	12J7GT 6/6	84 .... 8/-	9001 .. 3/-	OC44 6/-
							6L6 .. 9/-	12K7GT 2/-	85A2 .. 8/-	9002 .. 4/6	OC45 6/-
							6L6G .. 5/-	12K8M 10/-	90C1 .. 8/-	9003 .. 6/-	OC72 7/-
							6L6GA 7/6	12Q7GT 3/3	210VPT	9004 .. 2/6	OC81 7/-
							6L7G 4/-	12SA7 7/-	7-pin 2/6	9006 .. 2/6	OC82 10/-
							6L34 .. 4/6	12SC7 4/-	220PA 7/-		
							6LD20 5/9	12SG7 3/-	220TH 4/-		
							6N7 .. 6/-	12SH7 3/-	225DD 9/-		

MANY OTHERS IN STOCK including Cathode Ray Tubes and Special Valves.

All U.K. orders below £1 P. & P. 1/-: over £1 2/-: orders over £3 P. & P. free: C.O.D. 3/6 extra. Overseas Postage Extra at Cost.

MARCONI COMMUNICATION RECEIVERS.

C.R.150. Frequency coverage 2-60 Mc/s. in 5 bands. Two I.F.s 1st 1,600 kc/s. 2nd 465 kc/s. Image signal protecting over 40 dB up to 30 Mc/s. and 20-40 dB from 30-60 Mc/s. Self-checking calibration (built-in calibrator). Stabilisation of supply and temperature compensation. Electrical and mechanical bandspread. Metering and visual tuning indicator. Band pass from 100 c/s to 10 kc/s. in 5 stages. Acoustic filter associated with 100 c/s. Band-pass position for CW reception. Facilities for diversity reception. Excellent checked condition, **£49.** Mains P.S.U. by P.C.A. Radio, **£4/10/0** carriage 30/-.

C.R.150/2. Frequency coverage 1.5-22 Mc/s. in 4 bands, all other features as in C.R. 150. Price **£35.** Carriage 30/-.

P.C. RADIOS mains P.S.U. for above **90/-.**

DUMONT MODEL 241 OSCILLOSCOPE in fully working condition **£22/10/-.** P. & P. 30/-.

" CONNECT AND FORGET, CANNOT OVERCHARGE " " ESSTRON " MARK I AUTOMATIC BATTERY CHARGER. Initial charging rate 6-7 amps. The charging rate automatically adjusts itself to the charge in the battery. Automatic current and voltage control. Patented application of magnetic amplification to battery charging Indicator lights show battery fully charged, receiving charge incorrectly connected orfaulty cells. Mains voltage 200/250 v. Built for 6 or 12 v. batteries. Measurements 7x5x5¼in. Weight 8¼lb Price **£7/19/6.** P.P. 3/6.

SIGNAL GENERATOR MARCONI TF 995A-1. Range 1.5-220 Mc/s. in 5 bands. Output voltage variable in 1dB steps from 1μV to 100mV. Carrier may be unmodulated, frequency modulated, amplitude modulated, or simultaneously frequency and amplitude modulated. Frequence deviation is variable from 25-600 kc/s. for FM and modulation (internal or external) up to 50% for AM. Crystal calibrator for checking frequencies incorporated. Incremental frequency control. Fully checked and guaranteed. Price **£88/15/0.** Carriage in U.K. 30/-.

TELEPHONE HANDSET. Standard G.P.O. type, new **12/-.** P. & P. 2/-.

Large selection of mains and Heavy Duty L.F. TRANSFORMERS.

VARIOMETER for No. 19 set, **17/6** each. P. & P. 3/-.

Large Selection of SPARE PARTS for 53 TRANSMITTERS.

NEW CHR. HIGH-RESISTANCE HEADPHONES. 14/-. P. & P. 1/6.

EVERSHED MEGGER CIRCUIT TESTER 2 ranges. 0-1,000 ohms. 100-200,000 ohms, with test leads, leather carrying case. Tested **£4/19/6.** P. & P 3/6.

R.209: RECEPTION SET. A 10-valve high-grade Super Heterodyne Receiver with facilities for Receiving R/T (A.M. or F.M.) and G.W. frequency 1 Mc/s-20 Mc/s. Hermetically sealed. Built-in miniature valves and incorporating its own vibrator power supply unit driven by a 6 v. battery (2 point connector included). The set provides for reception from rod, open wire or dipole aerial with built-in loudspeaker or phone output. Overall measurements: Length 12in., width 8in., depth 9in. Weight 23lb. in as new, tested and guaranteed condition. **£23/10/-.** including special headphones and supply leads. Carriage £1.

AR88D RECEIVERS. Fully reconditioned **£55,** rebuilt models **£85.** Brand new **£95.** Carriage paid U.K.

CARBON INSET MICROPHONE G.P.O. types **2/6.** P. & P. 1/6.

RELAYS. Large selection of new relays type 600 and 3,000.

32/34' AERIALS each consisting of ten 3', ⅞" dia tubular screw-in sections, 14' (7 section) whip aerial with adaptor to fit the ⅝" rod, insulated base, stay plate and stay assemblies, pegs, reamer hammer etc. Absolutely brand new and complete, ready to erect, in canvas bag. **£2/19/6.** P. & P. 10/6.

CONNECTORS FOR TCS RECEIVER TRANSMITTER AND REMOTE CONTROL with original plugs on both ends. New, **£1/17/6** each. P. & P. 2/6.

PANEL METERS (round)

0-50 microamps	2½in.	D.C.**	40/-
0-100 microamps	2½in.	D.C.**	35/-
0-100 microamps	2½in.	D.C.**	35/-
0-500 microamps	2½in.	D.C.	30/-
0-1mA*	2in.	D.C.	19/6
0-1mA	3½in.	D.C.**	35/-
0-5mA	3½in.	D.C.	45/-
150-0-1,500mA.	3½in.	D.C.	29/-
0-15v.	2½in.	A.C.	17/6
0-50v.	2½in.	D.C.	28/-
0-150v.	2½in.	A.C.	24/-
0-500v. (shunt)	2½in.	D.C.	20/-
0-10kV.	2½in.	D.C.	63/-

*Weston, as usually used also in H.R.O. as " S " meter.
**Projection type.

POWER SUPPLY & L.F. AMPLIFIER UNIT NO. 3. Input 12 v. 3 amp. Output 145 v. 50 mA. Synchronised vibrator and extremely efficient smoothing. Stabilized heaters supply. Valves, IL4 & 3A4. Many practical possibilities i.e., car radio, etc. Diagram supplied. Brand new, **37/6.** P. & P. 8/-.

WELL PROVEN RELIABLE COMMUNICATION RECEIVER P.C.R.2. (Made by Pye.) 120 kc-350 kc. 525 kc.-1600 kc. 6 M.c.-22 M.c. Overall sensitivity 1-2μV. S/Noise ratio 10dB at 6μV. Circuit incorporates an R.F. stage, two I.F. stages. tone control, A.V.C. antenna trimmer, 6V6 output. Set in fully working condition together with headphones and speaker plug. **£7/12/6,** Carriage 15/-. Ditto but with built-in power supply for 210/250v. A.C. **£9/19/6,** Carriage 15/-.

P. C. RADIO LTD.
170, GOLDHAWK RD., W.12
SHEpherd's Bush 4946

Open 9-5.30 p.m. except Thursday 9-1 p.m. **PERSONAL CALLERS WELCOME**

TEST METERS

30,000 OHMS PER VOLT MODEL 500. Reads voltages up to 1,000 D.C. at 30,000 ohms per volt and A.C. at 12 amps. Resistance to 60 Megs.; Decibels from −20 to +56; Incorporates internal buzzer for audible warning of direct shorts and flocking condenser for A.F. output measurements. Size 3⅝ × 6⅝ × 2¾in. **£8/19/6.**

2,000 OHMS PER VOLT MODEL TP-10. Reads A.C. and D.C. volts up to 1,000; D.C. current to 500mA; Resistance to 1 Meg.; Capacitance to 1μF; Decibels from −20 to +36; Output jack for Audio measurements. Size: 3½ × 5 × 1¼in. **£3/19/6.**

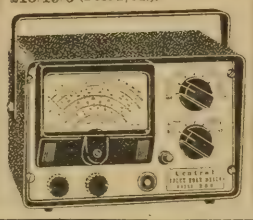
20,000 OHMS PER VOLT MODEL TP-5S. Reads voltages up to 1,000 D.C. at 20,000 ohms per volt and A.C. at 10,000 o.p.v.; D.C. current to 500mA; Resistance to 10 Megs.; Capacitance to 0.1μF; Decibels from −20 to +36. Size: 3½ × 5½ × 1¾in. **£5.19.6.**

R.C.A. TYPE AR.88D. RECEIVERS. BRAND NEW in makers cartons with spares. **£85.** Carr. 30/-

TRANSISTORISED INSULATION TESTER One handed operation, no cranking of generator 3 testing voltages 100, 250 and 500, to measure up to 500 Megohms. Complete with leather carrying case and test leads. ONLY **£17/10/-.** Illustrated details on request.

HIGH FREQUENCY A.C. VOLTMETER. A First Grade Moving Iron Instrument with 6in. Mirror Scale, reading up to 150 v. A.C. at 400 and 1,200-2,400 cycles. In substantial Oak case with removable lid, overall size 8½ × 8½ × 5½in. Made for the Air Ministry by Everett Edgcumb, and in perfect order. Brand New and Unused. ONLY **£5.** Can also be supplied for 50 cycles, use either 0-150 or 0-300 volts.

VALVE VOLTMETER D.C. Input Impedance 11 Megohms. 7 Voltage ranges, D.C. to 1,500, A.C. to 1,500 R.M.S., 4,200 Peak to Peak. Resistance .2 ohm to 1,000 Megohms. Centre zero setting for receiver alignment. Complete with A.C./D.C. probe and leads. Full illustrated details on request. ONLY £13.19.6 (Post 3/6d.).



MOVING COIL OMNI-DIRECTIONAL 50K IMPEDANCE MIKE. Chrome plated with diecast frame. ONLY **99/6.** (Post 2/6.)

MOVING COIL 50K IMPEDANCE STICK MIKE. A superb job. **75/-.** (Post 2/6.)

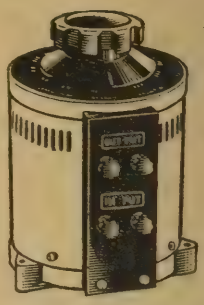
MOVING COIL STICK MIKE, complete with heavy desk stand, and screened lead. **ONLY 59/6.** (Post 2/6.)

ACOS 39/1 STICK MIKE with screened lead and table stand. ONLY **32/6.** (Post 1/6.)

CRYSTAL DESK MIKE with screened lead and built-in stand. ONLY **15/-.** (Post 1/6.)

ADJUSTABLE MIKE STANDS with heavy bases, and plated stems. Table type **29/6.** Floor type **59/6.**

15 OHMS P.M. SPEAKERS. Special Heavy Duty 12in., **£5 5/-.** Wharfedale W12EG 12in. for Lead Guitars, **£10/10/-.** Wharfedale W15EG 15in. for Bass Guitars, **£17/10/-.** 12in. wedge type speaker cabinet, **£2.17/6.** (Please add 5/- carr. all items.)



VARIABLE VOLTAGE TRANSFORMERS. Fully shrouded. Input 230 v. A.C. 50/60 cycles. Output 0-260 v. 2.5 amps. type **£5/17/6.** 5 amps. type **£9.** 10 amps. type **£16/10/-.** Portable 2.5 amps type with Output Voltmeter **£9/17/6.** Brand new import, fully guaranteed. Immediate delivery and service. Illustrated details on request.

LINEAR AMPLIFIERS

LG34, 4 watts, size 8½ × 4½ × 2½in. high. **£5/5/-.** L45A 5 watts, size 7 × 7 × 5in. high, **£5/19/6.** Protective cover, **12/9.** L5/55 5 watts stereophonic, size 10½ × 8 × 6in. high, **£12.12/-,** cover with carrying handles **25/-.** "Diatonic" 10 watts H-F Ultra Linear Push-Pull, size 9 × 7 × 6½in. high. **£12.12/-.** Cover with carrying handles, **19/6.** L1/10 10 watts Hi-Fi Ultra Linear, size 9 × 7 × 5in. high. **£13/13/-.** Cover with carrying handles, **19/6.** "Conchord" 30 watts Hi-Fi Ultra Linear, size 12½ × 9 × 7½in. high. **£16/16/-.** Cover with carrying handles, **25/-.** L50 50 watts Hi-Fi Ultra Linear, size 14 × 10 × 8in. high. **£23 2/-.** Cover with carrying handles **32/6.** All amplifiers for normal A.C. mains, and ex stock. Details on request.

"Tripletone" Convertible Amplifier, size 10 × 3 × 4½in. high. 4 watts output matched for 2-3 ohms, OR 2 amplifiers can be coupled together for STEREO, **£6.19/6** each.
"Tripletone" F.M. Tuner, size 11 × 6 × 3in. high. Coverage 86-104 mc/s. **£13/19/6** (unpowered), or **£15/14/6** (self powered). Details on request.

HETERODYNE FREQUENCY METERS TYPE LM14

Frequency range 125-20,000 kc/s. in 2 bands. This is the United States Navy Mode of the well-known BC221 Frequency Meter, but has many additional features which increase its usefulness. Voltage stabilisation circuits and Crystal control ensure extreme accuracy and in addition it is fitted with an Internal Modulation switch to allow use as a Signal Generator, Size only 8½in. × 8in. × 8½in. Brand New. **£25.**

DOUBLE BEAM OSCILLOSCOPE TUBES TYPE CV 1596. Equivalent to Cossor 09D. Brand new in Makers' Crates, **25/-** (Carriage 5/-).

HARRIS ELECTRONICS (LONDON) LTD.

138 GRAY'S INN ROAD, LONDON, W.C.1 *Telephone TERminus 7937*

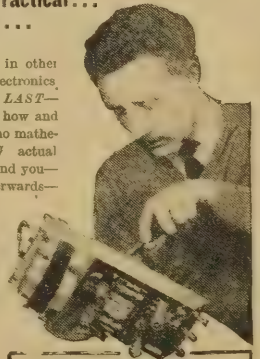
Please include carriage costs on ALL items. Open until 1 p.m. Saturdays.

We are 2 mins. from High Holborn (Chancery Lane Station) and 5 mins. by bus from King's Cross.

NEW!

DO-IT-YOURSELF TRAINING TECHNIQUE in RADIO & ELECTRONICS YOU LEARN while you BUILD...

Simple... Practical... Fascinating...



ANNOUNCING—after years of successful operation in other countries—the latest system in home training in electronics, introduced by a new British training organisation. *AT LAST*—a simple way of learning—by practical means—the "how and why" of electronics with the minimum of theory and no mathematics! *YOU LEARN WHILST BUILDING* actual equipment with the components and parts which we send you—and you really have fun whilst learning! And afterwards—you have a first-rate piece of home equipment plus the knowledge of how it works and how it can be serviced. *THIS NEW SYSTEM* brings you an exciting new opportunity at a very moderate cost—and there are *NO MATHEMATICS!* Post the reply coupon *TODAY* for *FREE* Brochure, to Britain's Leading Radio Training Organisation.

BUILD YOUR OWN—
- *RADIO EQUIPMENT*
- *HI-FI INSTALLATION*
- *TEST EQUIPMENT*

AND LEARN AS YOU DO IT

LOTS OF INSTRUCTIVE EXPERIMENTS AT HOME!

No Mathematics!

FREE— POST TODAY

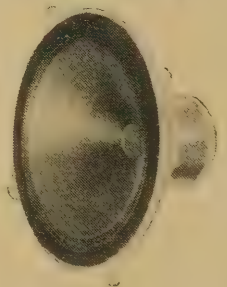
To: RADIOSTRUCTOR (Dept. G106) Reading, Berks.
Please send Brochure without obligation to
Name ..... } BLOCK CAPS PLEASE
Address ..... } 11.64
We do not employ representatives

RADIOSTRUCTOR

14WW—149 FOR FURTHER DETAILS.

12" GUITAR HEAVY DUTY 25w

with LIFETIME GUARANTEE—5 gns



Cast aluminium frames — no resonance steel magnet assemblies, bolted together —no rivetted or glued inaccessible parts.

20-10,000 cps, 15 ohm voice coils. Unlimited applications. Flat response 100 to 6,000 cps. magnet 12,000 lines. Price for quality unbeatable.

Manufacturers, Trade and Factors Terms.

Full Repair and Modernisation Scheme on all Post-War Models. Specials built to order.

Send for details:

BENSHAM MANOR ROAD PASSAGE THORNTON HEATH, SURREY

BAKER'S 'Selhurst' RADIO

Telephone: **THORNTON HEATH 1665**

PROOPS Walk-around Store and MAIL ORDER SERVICE

52 Tottenham Court Road, London, W.1. • Open 9-6, including Sats., Thurs. 9-1 • LANgham 0141

6-12 volt BLOWER UNIT 25/- *P. & P. 2/6.*

Self-contained assembly of compact, continuously rated motor and encased centrifugal fan. Smooth, silent running and providing a powerful blast of air from 1in. outlet pipe. Ideal for use with car heating and conditioning systems or to provide local cooling of hot running equipment and machinery. Operates from 6 volts D.C. (2 in series work on 12 volts) but can also be operated from 12 volts with 2 ohms 20 W resistor. Size overall: MOTOR, 2½in. diam. × 2¾in. long; FAN 6¼in. diam. × 1in. thick. In sparkling, unused condition.

MINIATURE SUBMERSIBLE WATER PUMP 10/6 *Post free*

For Aquaria, Table Fountains, Plant Humidity Control

Totally enclosed in durable non-corrodible case, only 2¼in. long × ¾in. dia. Weight 1½ oz. Self-priming but runs totally submerged and will pump 1 pint per minute at 1ft. head. Operates from 8-16 v. A.C.—absolutely safe, trouble-free supply that can be provided from the inexpensive transformer listed below. Complete with spare valve and spring and fitted with 27in. leads.

STEP-DOWN TRANSFORMER 7/6. *Post free.*
Works from any 200-240 v. A.C. mains supply and provides suitable output. Size 3¼in. × 2¾in. × 2¾in. high.

3-TRANSISTOR AMPLIFIER MODULE

Actually a highly sensitive 3-stage audio amplifier having a gain of 42 db and a response substantially flat up to 8 kc/s., but encapsulated in a volume approximately 0.1 cu. in. Brilliantly constructed with incredibly minute yet robust components. Utilizes 1 × OC75, 1 × OC88, and 1 × OC59 transistors. Input impedance 2,000 ohms at 1 kc/s. (100 ohms D.C.). Output 1,000 ohms at 1 kc/s. (1,500 ohms D.C.). Makes an excellent packaged unit for electronic stethoscopes, probes, listening devices, signal tracers, telephone amplifiers, etc. Size only ¾in. × ¾in. × ¼in. thick. Supplied complete with circuit and connection diagram.

30/- *Post free.*

Suitable miniature dynamic microphone, size ¾in. × ⅝in. × 3/16in. **4/-.** Suitable balanced armature miniature earpiece and flexible lead, **8/6.** Mallory cell battery for amplifier, size only ¼in. diam. × ¾in. thick, **2/6.** 20k. volume control ¼in. diam. × ¼in. thick, **1/6.**

STANDARD SOLENOIDS

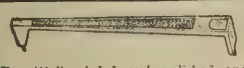
Specially made, high grade Solenoids in four basic frame sizes and for 12 v. D.C. or 240 v. A.C. pull or push operation. State requirements.

TYPICAL UNITS TYPE 1. Max. pull 9 oz. Stroke ⅛in. to ¾in. Size 2in. long. Bolt dia. 7/16in. **12/6** *Post and Packing* 1/-

TYPE 2. Max. pull 18 oz. Stroke ⅛in. to ¼in. Size 2 9/16 Send for list. **14/6** *Post and Packing* 1/-

TYPE 3. Max. pull 26 oz. Stroke ¼in. to ½in. Size: 2 11/16 in. long (bolt in) × 1 9/16in. wide × 1 13/16 high. Bolt dia. ¼in. **27/6** *P. & P.* 1/6.

TYPE 4. Max. pull 26 oz. Stroke ¼in. to 1¼in. Size: 3 7/16 in. long (bolt in) × 1 9/16 in. wide × 1 13/16 in. high. Bolt dia. ¼in. **32/6** *P. & P.* 1/6.



INSTRUMENT CASE HANDLES

Beautifully styled, cast, polished, and heavily chrome plated handles size 8¼in. long, ⅝in. tapering to ¼in. wide × 1 1/16 in. high (when installed). Fitted with 4 BA integral fixing studs on 8¼in. centres. A new, high quality product at a real bargain buy. **2/6** per pair, *Post & Packing* 1/-.

HIGH POWER MAGNETS

For Experimenters, Education, etc.

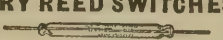
HORSESHOE MAGNET. Alcomax III Magnet. Complete with keeper, finished durable red crackle. Lifts 9 lbs., or about seventy times its own weight. Size overall ¾in. wide × ¾in. × 1in. high. **4/-.** *P. & P.* 9d.

LIMPET MAGNETS. Type 1.—Feroba. A powerful ceramic magnet contained in black enamelled mild steel case that will retain its full power in a lifetime of use. Lifts a tremendous 65 lbs., ¾in. diam. × ⅝in. thick. Does not require keeper, **12/6.** *P. & P.* 1/-.
Type 2.—Hycomax II. Size only 1¼in. diam. × ¼in. thick, but made of fantastic new material that provides a lift of 45 lbs.! Finished in grey crackle and complete with keeper. Drilled centrally to take lifting screw, **8/-.** *P. & P.* 1/-.

BAR MAGNETS. Made of Hycomax II and easily the most powerful Bar Magnets for their size available. Will lift 3½ lbs. Size only ¼in. sq. × 2in. long. Ideal for demonstration. **5/- per pair** *Post paid.*
ELECTROMAGNET. Powerful unit specially made for Proops for demonstration purposes, educational and experimental use. Operates from 12 v. D.C. and continuously rated to lift ¾ lb. Size overall: 1 13/16in. dia. × 1¾in. high and tapped 4 BA at top to facilitate permanent mounting. Magnet contact area 1¼in. dia. **8/6** *P. & P.* 1/-.

- **APNI Transducer Unit. 8/6.**
- **IN70 Diode Germanium Point Contact Diode equivalent OA85. Max. reverse voltage 115 v. Max. forward current 150 mA. Two for 2/6.**
- **WESTINGHOUSE SILICON DIODE. Type RCTD. Max. P.I.V. 1,000 R.M.S. 330 v. Max. current 500 mA. 7/6.**
- **AR88 WAVECHANGE SWITCHES. Ceramic wafers. Unused in original pack, 10/-** Post & Pkg. 1/6.
- **EDISWAN XA101 TRANSISTOR (equivalent Mullard OC45) two for 6/-.**
- **FILAMENT TRANSFORMERS. High quality drop-through type. Size: 3 × 2½ × 3¼in. deep. Input: 200/250 volts A.C. 50 cycles. Output: 6.3 volts centre tapped at 4 amps. New and guaranteed. Tremendous bargain offer, only 5/-.** Post & Pkg. 2/-.
- **120 VOLTS NEON M.B.C. Single base contact. Six for 7/6.** Post free.
- **MAINS NEON S.B.C. Twin base contact. Ten for 17/6.** Post free.
- **PIEZO CRYSTAL complete element with ribbon contact leads. Ten for 12/6.**
- **AR88 KNOBS. 2¼in. dia. Two for 6/-.** Post free.

DRY REED SWITCHES



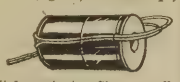
Basically a pair of gold diffused reed contacts hermetically sealed in a glass tube filled with inert gas. Contacts can be actuated by permanent, or electromagnets and so form ideal devices for a wonderful range of inexpensive devices such as burglar alarms, limit switches, position indicators, r.p.m. counters, night light controls, door bell switching, level controls, etc., etc. Reed switches have tremendous reliability factors and a working life of about 100 times that of micro switches, and the uses to which they can be put are limited only by imagination. **Each switch is supplied complete with specification, instructions and ideas information.**

7/- each. *post free.*

MINIATURE TYPE 8/6 *Post free*

Only 0.82 inches long by 0.15 inches thick. Maximum current for long life, 100 milliamps,

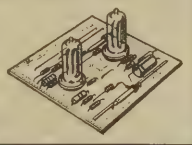
REED SWITCH COILS 4/- *Post free.*



Specially manufactured to provide electro-magnetic operation of Dry Reed Switches. Coil is simply pushed over glass tube envelope of switch and located round switch contacts. Size overall: ¼in. diam. × ⅝in. long. **Two types are available: Type 1—operates from any D.C. voltage from 1½ to 6 volts; Type 2—operates from any D.C. voltage from 6 to 12 volts. Please state type required when ordering.**

DIRECT READ-OUT COUNTER AND INPUT GATE

Make a really high-grade Direct Read-out Counter as economically as possible. Build it in separate stage-by-stage counting units that can be added on to provide any number of digits required. Specially designed. Date provides accurate counting up to 5 kc/s. from pulses of any shape having a minimum amplitude of 4 v. Complete kit of parts to build one Counting Stage, including Varoboard, Numicator and 11 valves **£10.10** *post free.*



INPUT GATE—complete kit including Varoboard and valves **42/6** post free.
Unit layouts and all circuitry supplied with each kit together with details of power supplies required. Stamp brings further details.

CADMIUM SULPHIDE PHOTO-CELLS

New, inexpensive photo-conductive cells which act as light-sensitive resistors that increase conductivity with increased light. These are 1,000 times more sensitive than selenium cells, with greater reliability, and can easily be built into a wide range of simple circuits. Typical used include automatic light controls for home and car, flashing barricade or breakdown lights, exposure meters, brightness controls, relay operation, and many other devices. Require only simple low power source from battery or mains transformer. Two types available.

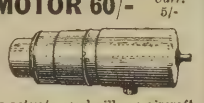
TYPE 1 TYPE 2

TYPE 1.—Max. voltage 200 v. Output 0.5 W. 10/- *post free.*

TYPE 2.—Max. voltage 150 v. Output 0.15 W. 8/6 *post free.*

Both types have a resistance range of 5 megohms at zero to 500 ohms at 1,000 lux. Sensitive range is 400-800 mu. Supplied with specification instructions and typical circuits.

ANTENNA BEAM ROTATING MOTOR 60/- *Carr. 5/-*



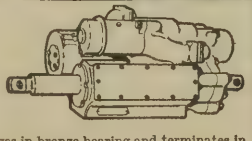
Magnificent series wound, split field motor which is ideal for beam rotation, winch operation, etc. Extremely robust unit incorporates a 600 to 1 epicyclic gearbox (output speed 12/15 r.p.m.) and a magnetic brake to prevent overrun, together with limit switches which allow rotation of approximately 3 turns in either direction. Originally designed for use on 24 volt D.C. to actuate cowl gills on aircraft, but limit switches can be disconnected to provide continuous running in either direction and removal of magnetic brake enables unit to be operated on any voltage between 6 and 30 volts A.C. or D.C. Size overall 12 × 3¾in. diam. with ¾in. diam. splined driving shaft × ¾in. long. Current consumption 4 to 6 amps. at 24 volts D.C. **In unused condition.**

ELECTRO/MECHANICAL COUNTERS 10/-

Post & Pkg. 1/6.

Ultra modern, miniature style, precision made units reading 0-9999. Fitted with 300 ohm coil. Size overall only 3¾in. long × ¾in. square. **In excellent guaranteed condition.**

TWIN MOTOR LINEAR ACTUATOR



Superbly constructed die-cast light alloy assembly containing main motor, an emergency motor, gear system, clutch, and two sets of adjustable limit switches. Emergency motor may be ignored or used to provide increased power. Normal load 1,500 lbs., travel 3in. in less than 10 seconds. Mounting is by massive steel lug on universal joint at fixed end. 1⅜in. dia. steel piston rod moves in bronze bearing and terminates in forked clevis fitting with ¾in. dia. fixing hole. Size overall 15in. × 7in. dia., for 24 v. D.C. operation at 6 A. In excellent unused condition. Many types in stock, send for Actuator List.

£17/10/- Carr. 10/-.

MINIATURE MAINS INDICATOR LIGHTS 4 for 5/- *Post Free*

Give positive indication that equipment, tools, instruments, apparatus, etc., is switched on. Complete assembly of neon, resistor, insulation and flying leads that requires only connection to switch. Small size and insulation permit simple fitting —just drill small hole in panel or tape or clip to equipment. Current consumption negligible. New manufacture.

Goldenair GROUP-MASTER 30 WATT GUITAR AMPLIFIER

A VERSATILE UNIT FOR INSTRUMENTALISTS AND VOCAL GROUPS
being suitable for clubs and public address.
Ideal for bass, lead or rhythm guitar, and all other musical instruments.

★ The two 12in. 25 watt heavy duty loudspeakers are specially designed for this type of amplifier, and give outstanding reproduction.
★ Robust attractive two-tone finished cabinet of compact size, 28in.×20in.×10½in., fitted with carrying handles.
★ For standard A.C. mains 50 c/s operation.
★ Four inputs provided can be used simultaneously with instrument pick-ups or mikes.
★ Separate Bass and Treble controls are incorporated.
★ A polished black control panel is fitted to the amplifier with distinctively marked control indications set in golf relief.

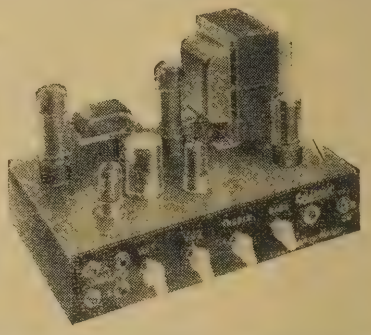
42GNS

or deposit of **£4.12.0.** and twelve monthly payments of **£3.12.5.** Carriage and insurance 25/- to be sent with deposit.

TWICE THE QUALITY AT HALF THE PRICE!
Customers are invited to see and hear this amplifier at our shop premises in Lambert's Arcade.
Send S.A.E. for leaflet.

THE Goldenair "THIRTY" HI-FI AMPLIFIER

A high quality 30-watt amplifier developed for use in large halls and clubs, etc. Ideal for bass, lead or rhythm guitars, schools, dance halls, theatres and public address. Suitable for any type of mike or pick-up. Valve line-up: two EF86; one ECC83; one GZ34; two EL34. Four separate inputs are provided with two volume controls. Bass and Treble controls are incorporated. Amplifier operates on standard 50 c/s. mains. 3 ohm and 15 ohm speakers may be used.
Perforated cover with carrying handles can be provided if required, price 21/-.



go Goldenair

TWICE THE QUALITY HALF THE PRICE

Customers are invited to see and hear this amplifier at our shop premises in Lambert's Arcade. Send S.A.E. for illustrated leaflet.

16GNS

or deposit of £1/16/- and twelve monthly payments of £1/9/2. Carriage 15/- to be sent with deposit.

SONA STREAMLINE MICROPHONE

Omni-directional response 60-10,000 c/s. Output level 52 dB. Built in on/off switch. Provision for conversion to hand-held, cord suspended on stand mike. Attractive satin chrome finish.

Microphone 37/6 P. & P. 1/9.
Deck Stand 10/- P. & P. 1/9.
Floor Stands Available.

2-WAY SOUND POWERED TELEPHONE

As used by the Armed Forces. These sound powered earpieces will work up to a distance of 1 mile without the use of batteries. Beautifully made, ideal for use in the house, office or garden. Complete with connecting cable, **17/6.** P. & P. 2/6.

No. 19 SET INSTRUCTION HANDBOOK 3/6 each P. & P. 6d.

1155 INSTRUCTION HANDBOOK 3/6 each P. & P. 6d.

H.R.O. INSTRUCTION HANDBOOK 3/6 each P. & P. 6d.

FREQUENCY METER B.C.221 3/6 each P. & P. 6d.

CRYSTAL SET

A wonderful educational set for all children. Provides hours of amusement while following the easy step by step instructions. It is powered entirely by wireless waves, eliminating the expense of batteries. No soldering required. Receives all main stations. Price **25/-.** P. & P. 2/6.

V.H.F. SIGNAL GENERATOR 1-130-A

A fine instrument with crystal/M.O. coverage 100 to 150 Mc/s. Slow motion tuning, with simple easily read scale. Stepped output and adjustable amplitude. Requires only a single plug in crystal, and power supply. Dimensions: 8in.×6in.×20in., in sturdy black crackle finish carrying case. Price **75/-.** P. & P. 5/-.

R.A.F. SHORT WAVE RECEIVER

35 to 40 Mc/s. Power supplies 12 volts and 250 volts D.C., in excellent condition with exceptionally fine slow-motion tuning and clean component layout. Price **£2/19/6.** P. & P. 6/-.

TYPE 19 SHORT WAVE RECEIVING SET

Works straight off the mains. An excellent short wave receiver, requires only phones for immediate operation. Price **£5/19/6.** P. & P. 2/6. Suitable phones **15/-** per pair. P. & P. 2/6. During an evenings testing on this excellent receiver, we obtained clear reception from scores of stations, many of them thousands of miles distant, including ship stations, Government transmission, maritime broadcasts and also the short wave radio Luxembourg broadcasts.

STABILISED POWER SUPPLY UNIT

Valuable unit comprising mains transformer, neon stabiliser etc., 50 c/s mains input 110 v. or 80 v. Stabilised output 130 v. D.C. and 6.3 v. A.C. Should make ideal battery eliminator. Price **29/6.** P. & P. 5/-.

WALKIE TALKIE No. 46

Compactly built to be carried by one man. This has a range of approx. 10 miles, and being crystal controlled, tuning is avoided, and operation is as accurate as a telephone. Frequency 3.6-9.1 mc/s. Complete stations comprising receiver transmitter, rod aerial. One set of headphones and mike, in canvas carrying bag but less the plug-in crystal coil unit, which is easily obtainable. Brand new in maker's sealed cartons. Price per station **£4/10/-.** P. & P. 10/- each. Two stations for **£9/10/-** post free.

VALVE SALE

All valves **2/6** each. P. & P. 9d. 2 for **4/6.** P. & P. 6d. 6K7G, EF50, 6H6, DF92, 6K8G, EB34, 1L4.

DOUBLE THROAT MIKES

Double throat mikes. Can be adapted for use with musical instruments. **5/11.** P. & P 9d

POSTAGE RATES APPLY U.K. ONLY. S.A.E. WITH ALL ENQUIRIES.
NEW WALK ROUND STORE OPEN IN LAMBERT'S ARCADE, LOWER BRIGGATE, LEEDS 1. NEXT TO HALFORDS CYCLE SHOP. OPEN ALL DAY SATURDAY. 48 HOUR DESPATCH SERVICE.
ALL MAIL ORDERS TO OUR BRIGGATE HOUSE ADDRESS

TERMS:
CASH WITH ORDER
5/- EXTRA ON C.O.D. ORDERS
No C.O.D. under 30/-

SONA

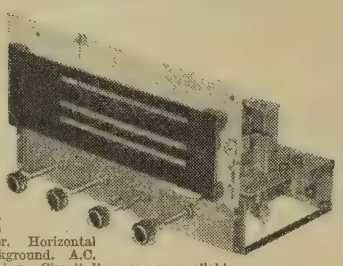
TRADE SUPPLIED
ORDERS FROM
ABROAD WELCOMED

Telephone: 34703

SONA ELECTRONIC CO., LTD. (Dept. W.W.7). BRIGGATE HSE., 13 ALBION PL., LEEDS

7 VALVE AM/FM RADIOGRAM CHASSIS

Valve line-up ECC85, ECH81, EF89, EABC80, EL84, EM81, EZ80.



Three Waveband and Switched Gram positions. Med. 200-550 m. Long 1,000-2,000 m. VHF/FM 88-95 Mc/s. Philips permeability tuning insert on FM and combined AM/FM IF transformers. Latest circuitry including AVC and Neg. Feedback. Three watt output. Sensitivity and reproduction of a very high standard. Chassis size 15½ × 6½in. Height 7½in. Edge illuminated glass dial 11½ × 3½in. Vertical pointer. Horizontal station names. Gold on brown background. A.C. 200/250 v. operation. Magic-eye tuning. Circuit diagram now available.

Aligned and tested ready for use **£13 . 10 . 0** *Carr. & Ins. 7/6*

Complete with 4 Knobs—walnut or ivory to choice. Indoor FM aerial 3/6 extra. 3 ohm P.M. Speaker only required. Recommended Quality Speakers 10in. Rola 27/6. 12in. R.A. 30/-. 12in. R.A. with Tweeter, 42/6. E.M.I. 13½ × 8in., 37/6. Carr. 2/6.

CO-AX 80 ohm CABLE

High grade low loss Cellular Air Speed Polythene—¼in. diam. Stranded Cond.

Now only 6d. yard

BARGAIN PRICES—SPECIAL LENGTHS
20 yds. 9/-. P. & P. 1/6. Coax. Plugs 1/-.
40 yds. 17/6. P. & P. 2/-. Sockets 1/-.
60 yds. 25/-. P. & P. 3/-. Couplers 1/3.

NEW BOXED VALVES ALL GUARANTEED

1T4	3/6		ECL82	10/-	PCF80 8/-
1R5,1S5	6/-		ECL80	9/-	PCL83 10/6
3S4,3V4	7/-		EF80	7/6	PCL84 9/-
DAF96	8/-		EF86	8/6	PL81 9/6
DF96			EL84	7/-	PL82 9/-
DK96			EY51	9/-	PL83 8/-
DL96			EY86	9/-	PY82 10/6
ECC81	7/-		EZ81	7/-	PY81 8/-
ECC82			GZ32	9/6	PY82 7/-
ECC83			PCC84	8/-	U25 10/6

TRIMMERS. Ceramic (Compression Type)—30 pF., 50 pF., 70 pF. 9d.; 100 pF., 150 pF., 1/3; 250 pF., 1/6; 500 pF. 1/9.

PHILIPS Bee Hive Type (conc. air spaced)—2-8 pF. 1/-; 30 pF. 1/-.

METAL RECTIFIERS-STC. Types—RM1 4/9; RM2 6/6; RM3 7/6; RM4 16/-; RM5 21/-; RM4B 17/6.

JACK PLUGS—2½in. Igranic type 2/6; Screened ditto, 3/3; 1¼in. Screened 2/3; Transistor type Min. & Sub.-min. 1/3.

JACK SOCKETS—Moulded Igranic type, open 3/6, ditto, closed 4/-. Pax. type open 2/6, ditto, closed 3/-. Transistor type closed, Min. & Sub-min. 1/6.

AR PLUG PHONES—Min. Continental type 3ft. lead, jack plug and socket. High Imp. 8/-. Low Imp. 7/6. M/Coil 12/6.

WAVECHANGE SWITCHES. 1 p. 12-way, 2 p. 2-way, 2 p. 6-way, 3 p. 4-way, 4 p. 2-way, 4 p. 3-way, long spindle, 3/6 ea.

STYLUS REPLACEMENTS. Diamond Styli for L.P. or Stereo, for all pop. types, B&R, Collaro, Garrard, etc., 11/3 ea. Gtd. 12 mths. SAPPHIRE ditto, 5/3 ea. Comp. range in stock.

TRANSISTOR COMPONENTS

Midget I.F.'s—465 Kc/s. ⅝in. diam. 5/6
Osc. Coil M/W ⅞in. dia.... 5/3
Osc. Coil M. & L.W. 5/9
Midget Driver Trans. 3.5 : 1 6/9
Midget Output Trans. Push Pull—3 ohms 6/9

Elec. Condensers—Midget Type 1 mfd., 50 mfd. ea. 1/9, 100 mfd. 2/-. 12 v. wkg.

Condensers 150 v. working: .01 mfd., .02 mfd., .03 mfd., .04 mfd. 9d., .05 mfd., .1 mfd. 1/-. .25 m d. 1/3; .5 mfd. 1/6, etc.

Midget Tuning Condensers J.B. "OO" 208 pf. and 176 pf. 8/6; ditto with trimmers 9/6. JB 220 pf. and 105 pf. conc. slow motion 10/6. 363 pf. single 7/6. Sub. Min. ⅜in. Dilemin 100 pf., 300 pf., 500 pf. 7/- each.

FERRITE AERIALS. M. & L.W. car aerial coil 9/3.

Midget Vol. Control with edge control knob. 4 K/ohms, with switch, 4/9. Ditto less switch 3/9.

Speakers: P.M.: 2in. Plessey 75 ohms 15/6. 2½in. Continental 8 ohms 13/6. 7 × 4in. Plessey 35 ohms 23/6. 2½in. Continental 8 ohms 13/6.

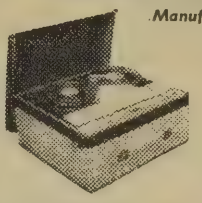
TRANSISTOR BARGAINS

Brand New—BVA 1st Grade

OC44	8/6	OC70	5/6
OC45	8/-	OC71	6/-
OC81	7/6	GEX34	2/9
GET114	6/6	OA70	2/9
OC72	7/6	OA81	2/9
AF117	9/6	OA79	2/9

ANOTHER TAPE RECORDER BARGAIN

Manufacturers end of production Surplus Offer



A 24 gn. Tape Recorder offered at the bargain price of only 15 gns. plus 10/- carr. Supplied in 3 Units already wired and tested. A modern Circuit for quality recording from Mike, Gram or Radio, using latest B.S.R. Twin Track Monardeck Type TD2.
Valve line-up—EF86, ECL82, EM84, EZ80 and Selenium Diode. Send for detailed list—3d. stamp.

Complete Kit comprising items below.
BARGAIN PRICE 15 Gns. +10/- Carr.

2-tone Cabinet and 8in. × 5in. Speaker. Size 14in. × 10in. × 7½in.	£3	10	0 + 5/- Carr.
Wired Amplifier complete with 4 Valves, front Panel, Knobs, etc.	£5	12	6 + 3/6 Carr.
B.S.R. Monardeck Type TD2	£7	7	0 + 4/6 Carr.
Accessories: Mike, Tape, empty Reel, screened Lead and Plugs, Instructions, etc.	£1	0	0 + 2/- Carr.

We manufacture all types Radio Mains, Transf. chokes, Quality O/P Trans., etc. Enquiries invited for specials, prototypes for small production runs. Quotation by return.

RECORDING TAPE

Famous American Columbia (CBS) Premier quality tape at NEW REDUCED PRICES. A genuine recommended Quality Tape—TRY IT Brand new, boxed and fully guaranteed. Fitted with leader and stop foils.

Standard		Double Play	
5in.	600ft. 13/-	1,200ft.	31/6
5½in.	900ft. 16/-	1,800ft.	37/6
7in.	1,200ft. 21/-	2,400ft.	47/6
Long Play		Post & Pack per reel, 1/- plus 6d. ea. for additional reels.	
5in.	900ft. 17/6		
5½in.	1,200ft. 19/6		
7in.	1,800ft. 28/6		

SPECIAL OFFER. 3in. Message tape 150ft. 3/9; 3in. L.P. 225ft. 4/9; 3in. D.P. 300ft. 6/6; P. & P. per reel 6d.
TAPE REELS. Mnfrs.' surplus 7in. 2/3; 5½in. 2/-; 5in. 2/-; 3in. 1/3; Plastic spool containers, 5in. 1/9; 5¼in. 2/-; 7in. 2/3.

SPEAKERS P.M. 3 ohms. 2½in. EMI, 15/6. 3in. Goodmans 16/6. 5in. Rola 15/6. 6in. Elac 16/6. 7 × 4in. Goodmans 15/6. 8in. Rola 19/6. 10in. Elac 25/-. 10 × 6in. Goodmans 22/6. 2½in. E.M.I. Tweeter, 22/6. 13½in. × 8in. E.M.I. 35/-.

ENAMELLED COPPER WIRE—½lb. reels 14g-20g 2/6; 22g-25g, 3/-; 30g-34g, 3/9; 30g-38g, 4/3; 39g-40g, 4/6, etc.

TINNED COPPER WIRE 16-22g., 2/6 ½lb.
VALVE HOLDERS—Int. Oct. 6d. Nylon or Ceramic, B7G, B9A unskirted, 9d. B7G B9A skirted 1/- each; B7G with Can 1/6; B9A with Can, 1/9, etc.

KNOBS—Modern Continental types:—Brown or Ivory with Gold Ring. 1in. dia. 9d. each, 1¼in. 1/- each, Brown or Ivory with Gold Centre 1in. dia., 10d. each; 1¾in. 1/3 each.
LARGE SELECTION AVAILABLE.

TYGAN FRET (Contem. pat.), 12 × 12in 2/-; 12 × 18in. 3/-; 12 × 24in. 4/-, etc. **BONDACOUST Speaker Cabinet Acoustic Wadding,** 12in wide, any length cut 1/6ft. 4/- yd. **EXPANDED ANODIZED METAL** Attractive gilt finish ¼ × ¼in. diamond mesh 4/6 sq. ft. Multiples of 6in. cut. Max. size 4ft. × 3ft. 47/6 plus carr.

JASON F.M. TUNER UNITS
Designer-approved kits available.
FMT1. 5 gns., 4 valves 20/-.
FMT2. £7. 5 valves 35/-.
JTV Mercury. 10 gns. 3 valves 22/6
JTV2. £13/19/6. 4 valves 28/6
NEW JASON F.M. HANDBOOK 2/6
48 hr. Alignment Services, 7/6 plus 2/6.

CONDENSERS—Silver Mica. All values 2 pf. to 1,000 pf., 6d. each. Ditto ceramics 9d. Tub. 450 v. T.C.C., etc. .001 mfd., .01 and .1/350 v. 9d. .02-1/500 v., 1/-. .25 Hunts 1/6. .5 T.C.C. 1/9 etc., etc.
CLOSE TOL. S/MICAS, 10% 5 pf.-500 pf. 8d. 600-5,000 pf. 1/-. 1% 2 pf.-100 pf. 9d. 100pf.-500 pf. 11d. 575 pf.-5,000 pf. 1/6.

RESISTORS—Modern ratings full range 10 ohms to 10 megohms. 20% ½-½ w. 3d. ea., ditto 1 w. 6d. ea., 2 w. 9d ea., 10% ½-½ w. 4d. ea., 5% Hi-stab, ½-½ w. 6d. ea. (below 100 ohms and over 1 meg. 9d. ea.). 5% Hi-stab, ½ w. 1/6 ea., (below 100 ohms 2/- ea.).
WIREWOUND, 25 ohms to 10K. 5 w. 1/3. 10 w. 1/6. 15 w. 2/-.

PRE-SET T/V POTS. W/W 25 ohms-50 K. 3/-. 50 K.2 Meg. (Carbon), 3/-.

Electrolytics All Types New Stock
TUBULAR CAN TYPES

25/25v.	50/12v.	1/9	8+8/450 v. 4/6
50/50v.	100/25v.	2/-	32+32/275v. 4/6
8/450v.	4/350v.	2/3	50+50/350v. 6/6
16/60/450 v.		5/6	60+250/275v. 17/6
32/32/450 v.		6/6	100+300/275v 12/6

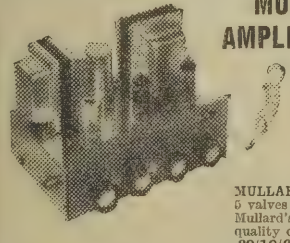
Transistor Midge types—all values 1 mfd. to 50 mfd. 1/9 ea., 100 mfd. 2/-, 12 v.

VOLUME CONTROLS—5K—2 Meg. ohms 3in. SPINDLES, MORGANITE MIDGET TYPE. 1¼in. dia. Guar. 1 year. LOG or LIN, ratios, less Sw. 3/- D.P. Sw. 4/6. Twin Stereo less Sw. 6/6. Some values with DP Sw. 8/6.

6 VALVE AM-FM TUNER UNIT

Med. and VHF 190 m.-550 m., 85 Mc/s-103 Mc/s, 6 valves and metal rectifier. Self-contained power unit, A.C. 200/250 v. operation. Magic-eye indicator, 3 push-button controls, on/off, Med., VHF, diode and high output with gain control. Perspex front panel 11½ × 4in. with 7in. illuminated dial. Overall size 11⅝ × 4 × 5¾in. A recommended Fidelity Unit for use with Mullard "3-3" or "5-10" Amplifiers. Available only at present as built-up units, aligned and tested ready for use. **Bargain Price £12/10/-.** Carr. 5/-. **Available shortly in Kit Form at approximately 10 Gns.**

MULLARD "3-3" HI-FI AMPLIFIER. 3 VALVES 3 WATT



3 ohm and 15 ohm Output. Hi-Fi quality at reasonable cost. Bass Boost and Treble controls, quality sectional output transformer, 40 c/s-25 kc/s. ± 1 dB. 100 mV. for 3W., less than 1% distortion. Bronze escutcheon panel. Power take-off available. **Complete Kit only £6/19/6.** Carr. 5/-. Wired and tested 8 gns.

MULLARD "5-10" AMPLIFIER.
5 valves 10W. 3 and 15 ohms output.
Mullard's famous circuit with heavy duty ultra-linear quality output transformer. Basic amplifier kit price £9/19/6. Carr. & Ins. 7/6.
Ready built £11/19/6.

CONTROL PANEL KIT
Bass, Treble and Volume control swith 4-position selector switch and 11in. × 4in. escutcheon panel, £2/5/-. Carr. 2/6.
Amplifier Kit and Control Panel Kit £11/19/6. Ditto ready wired £14/10/-.

2-VALVE PRE-AMP. UNIT
Based on Mullard's famous 2-valve (2 × EF86) circuit with full equalisation, with volume, bass, treble, and 5-position selector switch. Size 9in. × 4in. × 2¼in.
Complete Kit £5/19/6. Carr. 3/6.

DE-LUXE RECORD PLAYER KIT

Incorporating 4 Sp. Garrard Auto-Slim unit and Mullard latest 3 watt printed circuit amplifier (ECL86 and EZ80), vol., bass and treble controls, with 8 × 5in. 10,000 line speaker. Contemporary styled two-tone cabinet, charcoal grey and off-white with matching blue relief. Size 17½in. x 16in. x 8in. A stylish unit capable of quality reproduction. Circuit and const. details 2/6 (free with kit).

COMPLETE KIT Carr. and ins. 10/-. **£13.19.6**

Illuminated Perspex control panel escutcheon 7/6 extra. Ready wired 30/- extra. 4 contemporary mounting legs (6 or 13in.), 12/6 per set.

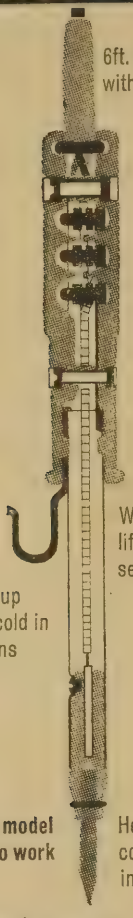
Only a few items are listed from our comprehensive stock. Write now for full bargain lists, 3d.

Terms: C.W.O. or C.O.D. post and packing ½lb. 9d., 1lb. 1/3, 3lb. 2/3, 5lb. 2/9, 10lb. 3/9, etc.

TRS RADIO COMPONENT SPECIALISTS *Established 1946*

70 BRIGSTOCK RD., THORNTON HEATH, SURREY
Tel.: THO 2188: Hours 9 a.m.—6 p.m. 1 p.m. Wednesday.

AN AEI PRODUCT


6ft. flexible lead with cordgrip
Will give a lifetime of service
Heats up from cold in 2½ mins
25 watt model for radio work
Heat concentrated in bit

Anatomy of a Superior Soldering Iron

The Solon range of electric soldering irons includes 15 and 25 watt models for radio, TV and electronic equipment; 65 watt models for household and workshop use. Larger models up to 240 watt also available.

Select a

SOLON

TRADE MARK

Used in industry for over 30 years
Obtainable from your usual radio or electrical supplier

14WW—150 FOR FURTHER DETAILS.

pitman

AN ELECTRONIC ORGAN FOR THE HOME CONSTRUCTOR

Alan Douglas, Sen. Mem. I.E.E.E.

A very popular "how to make it" book. Shows exactly what is involved in work and materials (a list of sources of supply is included) in constructing an inexpensive instrument for use in the home. For this new edition, an alterntivea arrangement of continuous tuning has been added to a revised and up-to-date text.

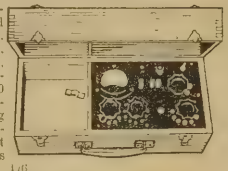
Second edition 20s net.

from all booksellers

Pitman, Parker St., London, W.C.2

14WW—151 FOR FURTHER DETAILS.

WHEATSTONE BRIDGE



Centre Zero Galvanometer Scaled 20 - 0 - 20 2½in. movement. 2.5 mA. full scale deflection. 3 stud switch controls 0-10, 0-100 ohms, 0-Inf. Complete in carrying case with instructions, **45/-**., Post 5/-. Spare meters for above **10/-**. P. 1/6.

RCA CANADIAN No. 29

Transmitter / Receiver 2-8 Mc/s., separate Manual tuning R.F. and Osc., also preset motor operated ditto. 25 miniature valves including 2/815's. 12/24 v. d.c. operation. Unused condition. Outside case store soiled **£12/10/-**. Carr £2. English version. Manual tuning only. Complete station, **£8/10/-**. Carr. £2.

TELESCOPIC AERIAL MASTS. Tubular steel copperised, spray finish, ring cam locking on each section provides for full or any height required. Suitable all fixings and base locations. Bottom section 1½in. diameter. 20ft. (4 section) Closed 5ft. 9in., Weight 16 lbs. **55/-** Carr. 5/-. 34ft. (6 section) Closed 6ft. 6in., Weight 20 lbs. **75/-** Carr. 5/-.
Further height by adding 3-4ft. Whipsections, **13/6**. Carr. 1/6 (Special price for quantities).

CREED TELEPRINTERS. 7B used condition, **£12/10/-**. Carr. 30/-.

B44 Mk. III. Dipole and rod aerials **30/-** per set. P. & P. 5/-.; Microphone with connecting plug, **15/6**. P. & P. 2/-; battery input and phone plugs **5/-** each. P. & P. 1/6.

POWER UNIT. 110/230 v A.C. input. 'C' type drop through Parmeko Transformer. 315 - 0 - 315 v, 6.3 v Output. Double choke and paper tap smoothing. Combined 4 valve including 4Z4 rectifier, 6B6 o.p. A.F. Amplifier. Self contained rack or table mounting. Fully fused. Indicator light. Mains switch. Brand new in makers cartons. **65/-** Carr. 5/- (Quality enquiries invited).

TRANSMITTER. 1.75-16 Mc/s., 3 waveband tuneable, grid modulation using 813. Used complete with all valves, circuit. **£7/10/-**. Carriage 10/-.

MOVING COIL HEADPHONES. BRAND NEW. Chamois padded, complete with jack plug, **15/6**. Post 2/-.

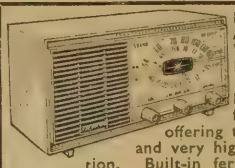
R.C.A. AR88D RECEIVERS. Brand new. **£75**. Carr. 30/-.

ALL NO. 19 SET PARTS AVAILABLE.

Many other bargains. S.A.E. all enquiries

A. J. THOMPSON
"Eiling Lodge," Codicote Hitchin Herts.
Phone: Codicote 224.

14WW—152 FOR FURTHER DETAILS.



BRAND NEW A.C. MAINS 5-VALVE SUPER-HET RADIO RECEIVERS

Housed in beautifully styled cabinets offering terrific performance and very high quality reproduction. Built-in ferrite rod aerial for reception of all your favourite programmes. Fully guaranteed.

MODEL 55. Covers Medium, Long and Short waves. Size 8½in. w. x 3¾in. d. x 4½in. h. **PRICE ONLY £7.17.6** P.&.P 5/6

Few only similar spec. to above but M.W. only **£4/14/6**. P. & P. 5/6.

SPECIAL OFFER—

HIGH GRADE TWO-STAGE GRAM AMPLIFIERS

Made by very well-known manufacturer.
Using a double-wound mains transformer (fully isolated chassis) with tapped primary, full wave contact cooled rectifier, and Mullard ECL82 triode-pentode valve. 3 watt output. Separate tone and volume controls. Overall size 6½in. wide x 3in. deep x 4½in. high. Each amplifier Brand New and tested and supplied complete with valve. 3 ohm output transformer and knobs. PRICE **49/6**, P. & P. 4/-.

BRAND NEW 3 OHM LOUDSPEAKERS

2½in. **12/6**; 5in. **12/6**; 6½in. **15/-**; 8in. **21/-**; 10in. **25/-**; 12in. **27/6** (15 ohm 12 inch **30/-**).
10in. x 6in. **26/-**
Latest type E.M.I. 13½in. x 8in. speaker with high flux ceramic magnet. 11,000 gauss. Aluminium centre cone. 10 watts, 50 c/s to 10 Kc/s. **42/-**. P. & P. up to 6in. **1/6**; over 6in. **2/6** per speaker.

SPECIAL OFFER!! BRAND NEW HEAVY DUTY 12 INCH SPEAKERS

Response 45 c/s.-13 kc/s. 1½in. voice coil. Available in 3 or 15 ohm. Guaranteed full 15 watts British rating. Heavy cast aluminium frame. These are current production by world famous maker and as they are offered well below list price we are not permitted to disclose the name.
LIMITED NUMBER ONLY.
UNREPEATABLE AT **89/6**. P. & P. 5/-.

SPEAKER AND CABINET FABRICS. Oatmeal or Red and Gold Vynair for speaker and cabinet covering. All 52in. wide and usually sold at 35/- yard. OUR PRICE **13/6** per yard length, plus P. & P. 1/9 per yard (Minimum order 1 yard). Send S.A.E. for samples.

BARGAIN OFFER CORNER

ROLA-CELESTION approx. 9in. x 6in. 3 ohm middle register speaker, **10/6**. P. & P. 2/6.

MAINS TRANSFORMER. Drop thru' type. Tapped primary 110 v. 200 v., 220 v., 240 v, 320-0 v., 320 v. at 80 mA. and 6.3 v. at 3 amps. Generous core. Stack size 3⅜ x 2¾ x 1⅝in. Weight 4lb. ONLY 15/-. P. & P. 3/6.

ACOS CRYSTAL MIKES. High imp. For desk or hand use. High sensitivity, **18/6**. P. & P 1/6.

TSL CRYSTAL STICK MIKE. Listed at 45/-. Our price **18/6**. P. & P .1/6.

CONTACT COOLED BRIDGE RECTIFIERS. 250 volts at 125 m/A. Size 1⅜in x 1⅛in. x ⅝in. **7/6**. P. & P. 1/-

TRANSISTOR DRIVER and O/P TRANSFORMERS. (Tapped 3 ohms and 15 ohms output), plus 4 suitable Transistors giving approx. 1 watt output 30/-. P. & P. 2/-.

T.C.C. SUPPRESSOR CONDENSERS. 250v A.C. .005+.005 x .1. In tubular can. 1⅜in. long x ⅜in. dia. 2 for **3/-**. Post free.

5,000 MFD. 12 V. WKG. CONDENSERS. Size 3 x 1in. diam. **2/-** each. P. & P. 6d. each.

T.V. OR AMPLIFIER EDGE CONTROL PANELS. Two 500k. Lin. Pots; one 500k. Log; one D/P. mains switch. Brand new **3/6** per panel. P.P. 1/-

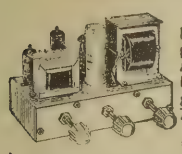
3-PUSH BUTTON SWITCH UNIT. 4 single pole changeover on each push-button. Approx. 3 x 1⅜ x ⅜in. An absolute Bargain at **4/6** each. P. & P. 1/- each.

Matched pair of 2½ watt Transistor Driver and Output Transformers. Stack size 1⅛in. x 1⅛in. x ⅜in. Output trans. tapped for 3 ohm and 15 ohm output. **10/-** pair, plus 2/- P. & P., worth double.

MARCONI QUARTZ CRYSTALS TYPES ZHB. Glass encapsulated, 2 wire lead out. Size 1⅛in. high x ½in. dia. Following frequencies (Kc/s) only available:—
13583, 13646, 13708 13771, 13833, 13896, 13958, 14021, 14083, 14146, 14208, 14271, 14333, 14396, 14459. **6/-** each. P & P. 1/ per crystal. 3 or more post free

Harverson Surplus Co. Ltd. ▶

3-VALVE AUDIO AMPLIFIER



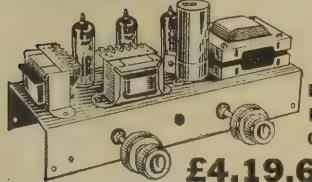
MODEL HA34

Designed for Hi-Fi reproduction of records. A.C. Mains operation. Ready built on plated heavy gauge metal chassis, size 7¼in. w. x 4in. d. x 4¾in. h. Incorporates ECC83, EL84, EZ80 valves. Heavy duty, double wound mains transformer and output transformer matched for 3 ohm speaker, separate Bass, Treble and volume controls. Negative feedback line. Output 4½ watts. Front panel can be detached and leads extended for remote mounting of controls.

The HA34 has been specially designed for us and our quantity order enables us to offer them complete with knobs, valves, etc., wired and tested for only **£4.5.0** P. & P. 5/-.

STEREO AMPLIFIER

Incorporating 2 ECL82s and 1 EZ80, heavy duty, double wound mains transformer. Output 4 watts per channel. Full tone and volume controls. Absolutely complete.



BARGAIN PRICE ONLY

£4.19.6 P. & P. 5/-.

6 TRANSISTOR AND DIODE SUPERHET

A first-class 2 waveband transistor superhet. ● Printed circuit panel (size 8½ x 2¾in.). ● 3 pre-aligned I.F. transformers. ● High-gain Ferrite rod aerial. ● All First-grade transistors. ● Car aerial winding. ● Push-pull output. ● All parts supplied with simple instructions.

All parts sold separately.

Set of parts if purchased at one time. **ONLY £4.5.0** P. & P. 2/6

Circuit diagram 1/6 (Free with set of parts).

35 OHM SPEAKERS

Suitable for use with above. 2in. Goodmans. Ideal replacement for most pocket portables **8/6** 3¼in. **12/6**; 5in. **17/6**; 7 x 4in. **21/-**. P. & P. 1/6 per speaker.

Portable CABINET

Size approx. 9½ x 6¾ x 3¾in. Suitable for above using 3¼in. speaker, **25/-**. P. & P. 2/-.

COIL AND TRANSFORMER SET FOR TRANSISTOR SUPERHET

3 I.F. transformers, one oscillator coil, one driver transformer and wound Ferrite aerial (med., long and car aerial coupling), **32/6** complete, post 1/-. 6 transistor printed circuit board to match, **8/6**, post 9d. Circuit diagram **1/6** extra.

SPECIAL TRANSISTOR BARGAINS ALL BRAND NEW

GET 15 (Matched Pair) **15/-**.

OC71...5/- OC76...6/- AF117...7/6 ORP12...10/6

Set of Mullard 6 transistors, OC44, 2-OC45, OC81D matched pair, OC81 **25/-**.

EDISWAN MAZDA

PXA101...6/6 XA103...6/6

R.F.1 Pack: 1—PXA102 Mixer; 2—PXA101 I.F. Amp.; (Equiv. OC44 and OC45)..... **10/6**

R.F.2 Pack: 2-PXA101 I.F., 1-PXA102 Osc.; 1-PXA102 Mixer **12/6**

L.F.6 Pack: Consisting of PXB113 Driver. Matched pair PXC171, mounted complete with heat sinks (Equiv. OC81D and OC81) **12/6**

ALL TRANSISTORS POST FREE

TAPE DECKS

B.S.R. MONARDECK (Single speed) 3¾in per sec., simple control, uses 5¾in spools, **£6/15/-**, plus 5/6 carr. and ins.

COLLARO STUDIO DECK 3 motors, 3 speeds, push button control. Up to 7in. spools **£10.10.0**. P. & P. 5/6. (Tapes extra on both.)

QUALITY RECORD PLAYER AMPLIFIER

A top-quality record player amplifier. This amplifier (which is used in a 29 gn. record player) employs heavy duty double wound mains transformer, ECC83, EL84, EZ80 valves. Separate Bass, treble and volume controls. Complete with output transformer matched for 3 ohm speaker. Size 7in. w. x 2½in. d.x 5¾in. h. Ready built and tested. **PRICE 69/6.** P. & P. 3/6. ALSO AVAILABLE mounted on board with output transformer and 6in. speaker ready to fit. into cabinet below. **PRICE 89/6.** P. & P. 4/6.

QUALITY PORTABLE R/P. CABINET Uncut motor board. Will take above amplifier and B.S.R. or GARRARD Autochanger or Single Record Player Unit. Size 18 x 14 x 8¼in. **PRICE £3/9/6.** Carr. 5/-.

EMBASSY PORTABLE RECORD PLAYER CABINET. Will accommodate amplifier, up to 7 x 4in. speaker and B.S.R. or GARRARD autochanger or single player unit. Attractive rexine covered finish. Overall size 17x15x8¼in. Supplied with uncut motor board. **PRICE 69/6.** Carr. 5/-.

4-SPEED PLAYER UNIT BARGAINS

All brand new in maker's original packing.

SINGLE PLAYERS

B.S.R. TU/12 ..... **£3/10/-**. Carr. 3/6.

B.S.R. GU7 with unit mounted pickup arm. **£4/18/8.** Carr. 4/-.

AUTO. CHANGERS

B.S.R. UA14	£5 19 6	B.S.R. UA15/16	£6 19 6
Latest B.S.R. UA25 Super slim			£6 2 6
GARRARD AT6 Mono.....			£10 10 0
GARRARD Auto-Slim			£6 10 0

Carr. 5/- on each.

BRAND NEW CARTRIDGE BARGAINS!

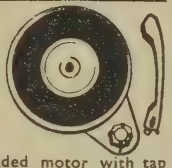
B.S.R. TC8S High output compatible STEREO CARTRIDGE. Brand new. Complete Stereo/LP/78 sapphire styli and universal mounting bracket. Original list price **44/11.** Our price **22/6.** P. & P. 1/-.

RONETTE STEREO 105 CARTRIDGE Stereo/LP/78 complete with two sapphires. Original list price **67/9.** Our price **24/-.** P.&P. 1/-.

COLLARO HI-FI STEREO CERAMIC t/o CARTRIDGE Type "C" complete with universal bracket and styli for stereo, L.P. and 78. Original list price **59/8.** Our Price **25/-.** P. & P. 1/-.

E.M.I. 4-speed Player and P.U.

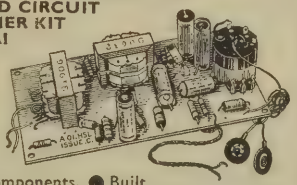
FURTHER HUGE PURCHASE enables us to offer these at 67/6 P. & P. 4/6.



Heavy 8¾in. metal turntable. Low flutter performance 200/250 v. shaded motor with tap at 45 v. for amplifier valve filament if required. Turnover LP/78 head.

HIGH GAIN 4 TRANSISTOR PRINTED CIRCUIT AMPLIFIER KIT

Type TA1

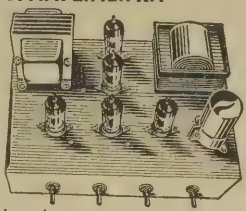


● Peak output in excess of 1½ watts. ● All standard British components. ● Built on printed circuit panel, size 6 x 3in. ● Generous size Driver and Output Transformers. ● Output transformer tapped for 3 ohm and 15 ohm speakers. ● Transistors (GET 114 or SI Mullard OC81D and matched pair of OC81 o/p). ● 9 volt operation. ● Everything supplied, wire, battery clips, solder, etc ● Comprehensive easy to follow instructions and circuit diagram 1/6 (Free with Kit). All parts sold separately. **SPECIAL PRICE 45/-.** P. & P. 2/6. Also ready built and tested, **52/6.** P. & P. 2/6. A pair of TAIs are ideal for stereo.

SPECIAL PURCHASE! TURRET TUNERS by famous maker

Brand new and unused. Complete with PCC84 and PCF80 valves, 34-38 Mc/s. I.F. Biscuits for Channels 1 to 5 and 8 and 9. Circuit diagram supplied. ONLY **25/-** each. P. & P. 2/6.

10/14 WATT HI-FI AMPLIFIER KIT



A stylishly finished monaural amplifier with an output of 14 watts from 2-EL84s in push-pull. Super reproduction of both music and speech, with negligible hum. Separate inputs for mike and gram allow records and announcements to follow each other. Fully shrouded section wound output transformer to match 3-15Ω speaker and 2 independent volume controls, and separate bass and treble controls are provided giving good lift and cut. Valve line-up 2 EL84s, ECC83, EF86 and EZ80 rectifier. Simple instruction booklet **1/6.** (Free with parts.) **All parts sold separately.** ONLY **£6/19/6.** P. & P. 6/6. Also available ready built and tested complete with standard input jack sockets, **£8/15/-.** P. & P. 6/6.

BRAND NEW Vynide covered wooden **CARRYING CASE** for above. Size 13¾ x 9 x 8in. with sloping front panel. Weight 4½ lbs. BARGAIN PRICE **28/6.** P. & P. 4/-.

A NEW HARVERSON KIT FOR THE HOME CONSTRUCTOR

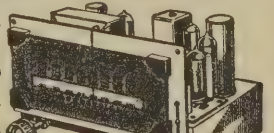
A really excellent, all purpose A.C. mains 200/240 v.

AMPLIFIER KIT.

TYPE HSL 'FOUR' 3 VALVE, 4 WATT USING ECC83. EL84, EZ80 VALVES.

Special features include: ★ Heavy duty double-wound mains transformer with electrostatic screen. ★ Separate Bass, Treble and Volume controls, giving fully variable boost and cut with minimum insertion loss. ★ Heavy negative feedback loop over 2 stages ensures high output at excellent quality with very low distortion factor. ★ Suitable for use with guitar, microphone or record player. ★ Provision for remote mounting of controls or direct on chassis. ★ All this builds on to a chassis size only 7½in. wide x 4in. deep. Overall height 4¾in. ★ All components and valves are brand new. ★ Very clear and concise instructions enable even the inexperienced amateur to construct with 100% success. ★ Supplied complete with valves, output transformer (3 ohms only), screened lead, wire, nuts, bolts, solder, etc. (No extras to buy). PRICE **79/6.** P. & P. 5/-. Comprehensive circuit diagram, practical layout and parts list 2/6 (free with kit).

HARVERSON'S F.M. TUNER Mk. I



● F.M. tuning head by famous maker. ● Guaranteed non-drift. ● Permeability tuning. ● Frequency coverage. 88-100 Mc/s. ● OA81 balanced diode output. ● Two I.F. stages and discriminator. ● Attractive maroon and gold dial (7 x 3in. glass). ● Self powered, using a good quality mains transformer and valve rectifier. ● Valves used ECC85, two EF80s, and EZ80 (rectifier). ● Fully drilled chassis. ● Size of completed tuner 8 x 6 x 5¼in. ● All parts sold separately. Set of parts if purchased at one time **£5/19/6,** plus 8/6 P.P. and ins. Circuit diagram and instructions 1/6 post free. **Mark II Version as** above but complete with magic eye, front panel and brackets, **£6/12/6.** P. & P. 8/6.

Mark III Version as Mark I but with output stage (ECL82) and tone control. **£7/7/-.** P. & P. 8/6.

Handsome Metal Cabinets. Choice of Grey, Black, or Green. To fit Mark I, **25/-.** P. & P. 2/6. To fit Mark II, **17/6.** P. & P. 2/6.

BRAND NEW CYLDON FM. TUNER HEAD

Permeability tuned 88-100 Mc/s. Printed Circuit. A completely screened unit ready for direct mounting in chassis. 10.7 Mc/s. I.F. O/P Supplied complete with ECC85 valve and full circuit diagram. Aerial input circuit suitable for either 75 ohm unbalanced or 300 ohm balanced. Size only 3in. w. x 2¾in. d. x 1¾in. h. (2¾in. high with valve). Limited number only at **27/6,** P. & P. 1/6. ALSO AVAILABLE 10.7 Mc/s. I.F. trans. and disc. trans. **11/6** pair. P. & P. 1/6.

GÖRLER F.M. TUNER HEADS

Tuning range 88-100 Mc/s. 10.7 Mc/s. I.F. **15/-,** plus 1/9 P. & P. (ECC85 valve, **8/6** extra.).

LOOK OPPOSITE FOR MORE BARGAINS

HARVERSON SURPLUS CO. LTD.

170 HIGH ST., MERTON, S.W.19. CHErrywood 3985

Open all day Saturday *Early closing Wed., 1 p.m.*

A few minutes from South Wimbledon Tube Station. *(Please write clearly)*

PLEASE NOTE: P. & P. CHARGES QUOTED APPLY TO U.K. ONLY. P. & P. ON OVERSEAS ORDERS CHARGED EXTRA. (Please enclose stamped addressed envelope with all enquiries.)

Z. & I. AERO SERVICES LTD.

Head Office: 44a, Westbourne Grove, London, W.2

Tel.: PARk 5641/2/3 **Cables: ZAERO, LONDON**

A.R.B. Approved for inspection and release of electronic valves, tubes, klystrons, etc.

RETAIL BRANCH (personal callers only): 85 TOTTENHAM COURT ROAD, W.2. Tel.: LANgham 8403

Please send all enquiries, correspondence and Mail orders to Head Office

MARCONI TF455D/1 WAVE ANALYSER

Mains operated instrument for direct measurements of components of complex waveforms in the frequency range of 20-16,000 c/s. and in the voltage range 100μV. to 100 v. Frequency measurements accuracy $\pm$2%. Distortion measurements within $\pm$5% to $\pm$10% accuracy. When lower accuracy and introduction of slight distortion are permissible, voltage range can be extended to 30μV. to 300 v. The instrument will also measure distortion in the A.F. modulating component of Low and Medium frequency carriers. Price, fully overhauled and guaranteed **£150.** Post & packing £2.

MARCONI TF-801A SIGNAL GENERATORS

Frequency range 10-300 Mc/s. in four overlapping bands calibration accuracy $\pm$1%. Output 200 mV. max. into 75Ω. Calibrated step attenuator 0 to $-$100 dB in 1 dB steps. Internal sinewave (up to 80%) and square wave (50-50) modulation at 400, 1,000 and 5,000 c/s. Provision for internal modulation. Power requirements 100-130 and 200-250 v. A.C. Fully overhauled and guaranteed. PRICE **£85 0 0**

R.F.T. TYPE FZI-2 FREQUENCY INDICATOR

Portable Mains operated Frequency Indicator for direct measurements of frequencies from 10 c/s. to 100 kc/s. The range is covered in 8 bands, the lowest being 30 c/s. F.S.D. Measurement accuracy $\pm$3% F.S.D. Input Impedance 100 kΩ. The instrument is provided with internal source of highly stable frequency for checking and recalibration of the scale. PRICE, new **£20/0/0.** Packing and carriage 15/-.

HETERODYNE CRYSTAL CONTROLLED V.H.F. FREQUENCY METER TYPE 183

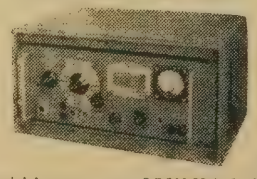
Frequency range 20 to 300 mc/s with accuracy of $\pm$.02%, and 5.0 to 6.25 mc/s, 10 to 12.5 mc/s, and 15-18.75 mc/s. Internal crystal 100 kc/s $\pm$ .005%. Beat indication by magic eye or headphones. Long linear scales directly calibrated in mc/s. Range can be extended to 1000 mc/s by using harmonic, with accuracy reduced to $\pm$ .3%. PRICE, new and guaranteed **£85 0 0**

VHF SIGNAL GENERATOR TYPE 2006

With F.M. and A.M. Modulation.

Very accurate A.M./F.M. Signal Generator covering a frequency range of 10 to 240 mc/s. in 10 bands. Calibration accuracy $\pm$.5%. Exceptionally long tuning scale with vernier dial. Output voltage continuously variable from .5μV. to 50mV. Output impedance 60Ω. Output voltage accuracy $\pm$2% on the stepped attenuator (up to 100 mc/s.). Internal modulation 1,000 c/s. up to 75% mod. depth (A.M.) and up to 100 kc/s. deviation (F.M.). Power supplies 115/230V. A.C. PRICE, new and guaranteed **£85/0/0.** Packing and carriage £1/15/0.

MARCONI TF934 DEVIATION TEST SET



Fundamental frequency range 2.5-100 Mc/s. basic; range can be extended to 500 Mc/s. by using harmonics. Deviation range 0-5, 0-25 and 0-75 kc/s. in the modulation range of 50 c/s. to 15 kc/s. Sensitivity better than 55mV. Power supplies 100-150 and 200-250V. A.C. Price fully overhauled and guaranteed **£85 0 0**

R.D.O. UHF/EHF RECEIVERS

This is an I.F. (300 Mc/s.) five-stage amplifier followed by A.F. and video stages. R.F. tuning is provided by interchangeable Tuning Heads or Units which cover frequency range of 38 to 4,000 Mc/s. Receiver....I.F. sensitivity is 16μV. approx. for an output of 6 mW. I.F. bandwidth is 4 Mc/s. Audio response can be set at 150-10,000 c/s. (broad) or 320-1,950 c/s. (narrow). Provisions are made for connecting the receiver to a Panoramic Adaptor (for observing frequency spectra) or to a Pulse Analyser. Power requirements—115 v. A.C. PRICE, fully overhauled and guaranteed, complete with Tuning Units TN1B, TN2B, and TN3B to cover frequency range from 40 to 1,000 Mc/s..... **£110 0 0**
Packing and carriage £2/10/0.

SOLARSCOPE TYPE CD514

Lightweight (42lbs.) portable Mains operated single Beam Oscilloscope employing a 4in. flat-face Tube and providing the following facilities: Y Amplifier with sensitivity of 30 mV/cm. max. and bandwidth 5 c/s. to 9 mc/s. (Full Beam deflection available up to 10 mc/s.); Stepped "Y" Attenuator; Internal Sinewave available for Y sensitivity calibration; Tutenal Calibrating waveform providing time marks at .1—1—10p.i.s. intervals. Time base 15 c/s. to 150, kc/s. providing sweep of 10 m/sec. to 50 mμsec. per centimetre. Power requirements 200-250V. A.C. PRICE, fully overhauled and guaranteed, **£60/0/0.** Packing and carriage £1/0/0.

MULLARD LOW FREQUENCY DOUBLE BEAM D.C. OSCILLOSCOPE TYPE L.203

This double beam oscilloscope uses single beam tube and an electronic beam switching circuit. It had been designed to cater for requirements of servo control, vibration analysis and medical applications. Short persistence tube with long yellow afterglow. Time base from .3 millisec to 10 sec. "X" trace expansion. Two separate A.C./D.C. amplifiers, calibrated in steps from .1 mV. to 1,000 v. Mains operation.
BRAND NEW, with manual £60. Packing and carriage £1/10/-.

MULLARD PRECISION MEASURING OSCILLOSCOPE TYPE L140/3

Sensitivity 4.5 mV. to 45 mV./cm. in ten steps. Rise Time .05μs. to .06μs.; Frequency response D.C. to 10 m.c. max. Sweep duration 5μs. to 150 m/sec. Time measurement for 0—5 μs. to 0-150 m./sec. with an accuracy of $\pm$3%. Large illuminated scales for Voltage and Time measurements. Switchable delay of .6μ/sec. 5-in. flat face C.R.T. with P.D.A. Power supplies and oscilloscope section are housed in two separate units, thus ensuring more flexible combination and easier handling. Power supplies required 20/250V. A.C. PRICE, brand new and guaranteed, **£125/0/0.** Packing and carriage £3/0/0.

THOMSON VARLEY POTENTIAL DIVIDERS

Iron-inductive 4-decade potential divider with total resistance of 70,000Ω. Maximum input voltage 300 v. Built-in galvonometer 1μA. F.S.D. **£45.**

MARCONI TF338B VARIABLE ATTENUATOR

Characteristic Impedance 600Ω. Internal/external termination. Range 0 to 105 dB obtainable by means of slidewire attenuator 0-25 dB and 4 steps of 20 dB each. Frequency response 0 to 105 dB within .2 dB. Maximum input 2 watts. **£20 0 0**

"MEASUREMENTS CORPORATION" TYPE 84 "STANDARD" SIGNAL GENERATOR

Range: 300-1,000 Mc/s. Direct Calibration.
Accuracy: 0.5%.
Output Level: 0.1μV.-100 mV. continuously variable.
Internal Modulation:—
Sinewave—30% Max. at 400, 1,000 and 2,500 c/s.
Pulse—1 to 50μsec., width delay variable from 0 to 50μsec., p.r.r. 60 to 10,000 c/s.
Output Impedance—50 ohms.
Percentage Modulation Meter.
PRICE, in as new condition, tested before despatch and fully guaranteed **£220 0 0**
Packing and carriage, £2.

TSX-4SE "X" BAND SPECTRUM ANALYSER

Spectrum Analyser covers a frequency range of 8,360 to 9,550 Mc/s. Self-contained wavemeter permits the tuning of the instrument with an accuracy of $\pm$4 Mc/s. It can be used for observing spectra of pulsed oscillators, for measuring frequency, for checking frequency pulling in the magnetrons and for measuring standing waves and attenuation.
PRICE, fully overhauled and guaranteed.. **£190 0 0**
Packing and carriage £2/10/-.

WAVEMETERS CLASS D

Self-contained portable wavemeter (6 v. accumulator operation) covering a range of 1,900 kc/s.-8,000 kc/s. (for heterodyning) with an accuracy of $\pm$2 kc/s. The instrument will also provide crystal check points, derived from internal 100 kc/s. crystal up to 25 mc/s. at 1 mc/s. intervals.
PRICE, in perfect condition and guaranteed **£3 10 0**
P.P. 15/-.

R.P.M. INDICATOR KIT

Radio-Altimeter Indicators with moving coil movement of 5 mA. F.S.D. easily convertible to accurate engine R.P.M. indicators. Supplied complete with parts required for conversion, and detailed instructions, Suitable for 4-cylinder engines with 12 v. electrical installation. **35/-.** P.P. 5/-.

POST OFFICE TYPE ELECTRO-MAGNETIC COUNTERS

4-digit non-cancelling type Standard, 1¼ × 1¼ × 5in., 2,300Ω coil, secondhand	5/-
Miniature 1 × 1 × 3¼in., available in 500Ω and 2,300Ω coils. Secondhand	6/6
Miniature 1 × 1 × 3¼in., 4.1Ω coil, 6 v. operation, new	8/6

BRAND NEW SEALED RELAYS

Advance G8755-IY, 65+5,000Ω, 1M, 15 v.....	12/6
Advance F8949-IY, 2×16,000Ω, 3B, 24 v.....	15/-
Advance C8940-I, 250Ω, 5B, 12.5v.	12/6
R.B.M. 22240-4, 200Ω, 6M, 12 v.	10/-
Elect. Spec. T-162F1, 10,000Ω, 1 C.O., 48 v....	12/6
Advance ES904-1, 300Ω, 2 C.O., 12 v.....	7/6
Potter Brandfield MH1769, 360Ω, 2 C.O., 24 v...	7/6

RADIO FREQUENCY THERMO-COUPLE METERS

200 mA. 2in. Round, plug-in.....	12/6
350 mA. 2in. Round, plug-in.....	12/6
1 amp. 2½in. Round, projecting.....	15/-
2.5 amps. 2in. Round, panel mtd.....	15/-
2.5 amps. 2in. Square, flange.....	25/-
3 amps. 2in. Round, panel mtd.....	25/-
3 amps. 2in. Square, flange.....	25/-
15 amps. 2½in. Round, flange.....	22/6

EVERSHED 250 B. "WEE" MEGGERS

Perfect condition. Complete with case.... **£14 10 0**

SELENIUM FULL WAVE CHARGING RECTIFIERS

12 Volts D.C. output:			
2.5A	7/6;	4A	12/6
8.0A	19/6;	18A	39/6
24 Volts D.C. output:			
2.5A	15/-;	4.0A	22/6
8.0A	39/6;	18.0A	79/6

SIGNAL DIODES

1N21	4/-	CS2A	5 -	CV425	1/6
1N21B ..	6/-	CS3A	10 -	CV442	1/6
1N23	4/-	CV101 ..	5 -	CV448	2/-
1N23B ..	4/6	CV102 ..	5 -	CV2258 ..	30/-
1N25	9/-	CV103 ..	5 -	HG5008 ..	2/-
1N28	20/-	CV111 ..	8 -	OA70	2/-
1N81	4/-	CV112 ..	8 -	OA79	2/2
CG10E ..	1/6	CV253 ..	10/-	OA81	2/-
CG83H ..	2/-			8X761	4/6

SILICON JUNCTION RECTIFIERS

SX645, 400 p.i.v., 190 mA. D.C.....	15/-
BY100, 700 p.i.v., 450 mA., D.C.....	7/-
OA211, 800 p.i.v., 400 mA., D.C.....	7/6
DD058, 800 p.i.v., 500 mA., sub miniature.....	12/6
BYZ10, 800 p.i.v., 6 amps. D.C., stud mounted....	7/6

GERMANIUM JUNCTION RECTIFIERS

Stud mounted

GJ3M, 200 p.i.v., 400 mA., D.C.....	3/6
GJ5M, 300 p.i.v., 400 mA., D.C.....	3/6
GJ7M, 80 p.i.v., 500 mA., D.C.....	3/6

Rating in free air. Current can be increased twofold if mounted on a heat sink.

CATHODE RAY TUBES

2DP1A	15/-	88D	40/-	VCR97I....	40/-
3FP7	12/-	89J	60/-	VCR138 ..	50/-
5CP1	30/-	ACR13 ..	30 -	VCR138A	60/-
5FP7	12/6	ACR22 ..	40 -	VCR139 ..	25/-
58P7	100/-	DG13/2 ..	80 -	VCR517B	40/-
5UP7	60/-	E4103/B/1	45/-	VCR517C	40/-
7BP7	20/-	O9D, O9J ..	80/-	VCRX214	60/-

14WW—153 FOR FURTHER DETAILS.

TRANSISTORS

MULLARD

OC26	8/-	OC70	5/-	OC78	7/-		
OC28	17/6	OC71	5/-	OC78D	7/-		
OC35	15/-	OC72	8/-	OC139	12/-		
OC42	8/-	OC75	6/-	OC170	8/-		
OC44	6/-	OC76	6/-	OC171	9/-		
OC45	6/-			OC204	10/6		

Set of matched pair of OC81 and one OC81D 12/6

G.E.C.

GET115	Audio 400/800mW	7/-
GET573	heavy current switching	20/-

R.C.A.

2N410	(I.F.—similar to OC45)	3/6
2N412	(Mixer—similar to OC44)	3/6
Set of two 2N410 and one 2N412		8/-

MICRO-ALLOY

MAT101—up to 60 Mc/s	8/6
MAT121—up to 120 Mc/s.	8/6
Philco T1166—similar to MAT121	6/-
TEXAS N.P.N. 28004	10/-

LOW POWER ZENER DIODES

OAZ203, 6.3 v. ± 5%, 260 mW	6/-
KS44B, 12.0 v. ± 10% 300 mW	6/-

2.25W ZENER DIODES

.3 v. tolerance:
4.25 v. (VR425); 4.75 v. (VR475); 5.25 v. (VR525); 5.75 v. (VR575); all at 6/6

.6 v. tolerance:
6.25 v. (VR625); 7.0 v. (VR7B); 9.0 v. (VR9B), all at 6/6

EDISON TYPE 501 THERMAL VACUUM DELAY SWITCH

Glass envelope, Octal Base. Filament Voltage 6.3V. nominal for 60 sec. delay. One make contact 3A capacity at 150 V. D.C. or 250 V. A.C. Delay Time adjustable from 40 to 80 sec. approx. by varying filament voltage.

KLYSTRONS

2K25	£4	5721	£50	CV6002	£40
2K28	£9	6116	£30	K302	£12
8K33	£45	6470	£75	K308	£12/10
2K41	£20	CV35	£5	K312	£10
2K45	£7	CV36	£6	K329	£200
417A	£2	CV67	£5	K335	£10
707B	£3	CV129	£4	VA220E	£35
723A/B	£3	CV238	£5	VA247C/IK	
726A	£4	CV2116	£10		£20
5550	£8	CV2242	£40		

MAGNETRONS

725A	£3	CV1495	£8	CV1500	£8
5586	£50	CV1496	£8	JP9-7D	£12/10
6510	£25	CV1497	£8	JPT9-01	£60
CV370	£12/10	CV1498	£8	QK338	£60
CV1494	£8	CV1499	£8		

DOUGLAS TRANSFORMERS

All for 200/250V. Input, 40-100 c/s.

H.T. POWER TRANSFORMERS:

MT2/AT, 350/0/350V. at 80mA., 0-4-6.3V. at 3.5A; 0-4-5-6.3V. at 2A..... 29/6

MT7/AT, 350/0/350V. at 100 mA., 6.3V. C.T. at 3.5A.; 6.3V. at 4A.; 0-5-6.3V. at 2A..... 32/-

MT11/AT, 300/0/300V. at 100mA., 6.3V. at 3A.; 0-5-6.3V. at 2A..... 31/6

MT23/AT, 250V. at 50mA.; 6.3V. at 1.75A..... 16/-

MT27/AT, 260/0/260mA. at 60mA.; 6.3V. at 2.5A.; 6.3V. at 1A..... 22/6

CHARGER TRANSFORMERS:

MT3/AT, 0-12-15-20-24-30V. at 2A..... 25/6

MT16/AT, 24V. at 5A..... 38/6

MT21/AT, 0-12-15-20-24-30V. at 4A..... 38/-

FULLY GUARANTEED FIRST QUALITY VALVES

OA2	6/-	5R4GY	9/-	6E5	7/-	10P13	12/6	28D7	7/-	954	5/-	6186	10/-	DET23	60/-	ECL83	9/-	KT8C	20/-	PY800	8/6	UY85	5/-
OA4G	17/6	5R4WGA		6EV5	12/-	10P14	13/-	28D7W	15/-	955	3/-	6189	10/-	DET24	70/-	ECL86	9/-	KT41	7/6	PY801	8/6	VGT121	
OB2	6/-		15/-	6F6	8/-	10Y	15/-	29C1	20/-	956	2/-	6202	8/-	DET25	15/-	EF36	4/6	KT44	5/-	PX4	15/-		15/-
OB3	6/-	5T4	8/-	6F6G	5/-	11D3	7/-	30	4/-	957	5/-	6205	10/-	DF33	8/-	EF37A	8/-	KT61	12/6	PY25	10/-	VGT128	
OC3	6/-	5U4G	5/-	6F7	5/-	11D5	7/-	30C15	10/-	958	4/-	6211	4/6	DF66	6/-	EF39	5/-	KT63	6/-	PZ30	10/-		10/-
OD3	5/-	5U4GB	6/6	6F8G	5/-	11E2	15/-	30C17	12/-	959A	8/-	6263	70/-	DF72	7/-	EF40	9/-	KT66	15/-	QP25	5/-	VLS631	15/-
OZ4	5/-	5V4G	8/-	6F13	6/6	11E3	25/-	30F5	9/-	991	7/-	6280	200/-	DF73	7/-	EF41	7/6	KT88	20/-	QQV02-6		VP23	3/6
1A3	5/-	5V4GT	5/-	6F17	6/-	12A5	10/-	30FL1	12/-	1622	12/-	6350	4/-	DF91	3/-	EF42	6/-	KTW62	7/-		45/-	VP41	5/-
1A5GT	5/-	5X4G	8/-	6F23	9/6	12A6	3/-	30L15	12/-	1625	6/-	6442	100/-	DF92	2/6	EF54	6/-	ME91	7/6	QQV03-10		VR78	3/-
1A7GT	8/-	5Y3	6/-	6F24	11/-	12A8GT	5/-	30L17	13/-	1626	3/-	6463	7/-	DF96	6/-	EF55	8/-	ME1403			35/-	VR92	2/-
1AD4	7/-	5Z4	9/-	6F28	10/-	12AC6	8/-	30P12	10/-	1635	12/-	6621	10/-	DH63	6/-	EF80	5/-			QV04-7	10/-	VS68	20/-
1B3GT	7/-	5Z4GT	8/-	6F32	3/-	12AH7GT		30P19	14/-	2050	12/6	7044	10/-	DK32	8/-	EF83	10/-	MH4	5/-	R2	8/-	VT4C	30/-
1B24	30/-	6/30L2	10/-	6F33	6/-		5/-	30PL1	10/6	2051	6/-	7551	30/-	DK40	11/-	EF85	6/-	MHLD6		R10	15/-	VT61A	7/-
1B24A	60/-	6A3	8/-	6G6G	2/6	12AH8	11/-	32	6/-	4033A	15/-	7586	22/6	DK91	5/-	EF86	6/6		12/6	R17	8/-	VU39	8/-
1B27	40/-	6A6	4/-	6H1	7/-	12AQ5	7/-	35A5	11/-	4043C	25/-	7895	22/6	DK92	9/-	EF89	4/6	ML6	6/-	R19	7/-	VU120A	
1B59	45/-	6A7	10/-	6H6	1/6	12AT6	5/-	35L6GT	7/-	4228A		8013A	25/-	DK96	7/6	EF91	4/-	MT57	80/-	RL18	12/6		10/-
1D5GP	8/-	6A8	8/-	6J4	9/-	12AT7	4/-	35T	40/-		1,400/-	8020	12/6	DL66	12/-	EF93	4/9	MU12/14		S130	12/6	W21	5/-
1G6GT	7/-	6AB4	6/6	6J5G	4/-	12AT7WA		35W4	5/-	4242A	30/-	9001	4/-	DL68	10/-	EF94	6/-		8/-	S130P	15/-	W81M	6/-
1H4G	6/-	6AB7	4/-	6J6	3/6		6/-	35Z3	10/-	4687	17/6	9002	5/6	DL69	12/6	EF95	5/6	N78	15/-	SP41	4/-	X65	5/6
1H5GT	7/-	6AC7	3/-	6J6W	6/-	12AU6	6/-	35Z4G	4/-	5514	50/-	9003	9/-	DL70	7/-	EF98	10/-	NR8S	12/6	STV280/		X66	8/-
1L4	2/6	6AF4	11/-	6J7G	5/-	12AU7	5/-	35Z4GT	6/-	5517	6/-	9004	2/6	DL73	12/-	EF183	8/-	NSP1	25/-	80A	60/-	X79	18/-
1L6	17/-	6AG5	2/6	6J7GT	7/6	12AV6	6/-	35Z5GT	6/-	5559	50/-	9006	2/6	DL75	10/-	EF184	8/-	NSP2	22/-	8U2150A		XC11	12/6
1N5GT	8/-	6AG7	6/-	6K7	5/-	12AV7	8/-	38	5/-	5626	120/-	A239	12/6	DL92	5/-	EFP60	10/-	OCP71	24/-		10/-	Z66	10/-
1P21	120/-	6AH6	10/-	6K7G	2/-	12AX7	6/-	41	5/-	5636	10/-	A1834	22/6	DL93	4/-	EL32	3/-	ORP12	12/-	TH41	10/-	Z319	17/6
1Q5GT	8/-	6AJ5	9/-	6K7GT	5/-	12AX7	10/-	42	5/-	5641	12/6	A2134	8/-	DL94	5/6	EL34	10/-	ORP60	10/-	TH233	6/-	Z700U	4/-
1R4	6/-	6AK5	5/6	6K8	8/-	12BA4	9/-	50B5	7/-	5651	8/-	A2226	18/-	DL95	6/6	EL35	5/-	P41	8/-	TH2321	7/-	Z759	22/-
1R5	5/-	6AK5W	8/-	6K8G	4/-	12BA6	6/-	50C5	6/6	5651WA		A2293	15/6	DL96	6/-	EL36	9/-	P61	3/-	TP22	5/-	Z800U	20/-
1S4	5/-	6AK6	7/-	6K8GT	8/-	12BE6	5/-	50C10GG			15/-	AC/TH1		DLS10	12,6	EL37	17/6	PABC80		TP25	5/-	Z801U	30/-
1S5	4/6	6AK7	6/-	6L6	9/-	12BH7	8/-		25/-	5654	8/-		14/-	DLS19	15/-	EL38	17/6		7/-	TP2620	7/6	CV58	30/-
1T4	3/-	6AL5	3/-	6L7	5/-	12BY7	10/-	50L6GT	6/6	5663	7/-	AC/P4	4/-	DM70	5/-	EL41	7/6	PC86	12/-	TT15	35/-	CV82	40/-
1T5GT	6/-	6AM5	2/6	6L18	8/-	53KU	9/-	5665	200/-	AC5/		DY30	7/-	DM160	12/-	EL42	8/-	PC88	12/-	TT21	32/-	CV132	6/-
1U4	5/-	6AM6	4/-	6N7	8/-	12E1	20/-	75B1	5/6	5670	10/-	PENDD	8/-	DY80	7/-	EL81	8/6	PC97	9/-	TT22	32/-	CV284	5/6
1U5	6/-	6AN5	10/-	6P1	11/-	12F5GT	8/-	76	5/-	5672	7/-	AC6/		DY86	8/-	EL83	7/-	PCC84	5/6	TTR31	60/-	CV286	5/6
1V	5/-	6AQ5	6/-	6Q7G	6/-	12H6	3/-	77	5/-	5676	10/-	PEN	6/-	DY87	9/-	EL84	5/-	PCC85	7/-	TZ40	40/-	CV287	8/-
1X2A	7/-	6AN5	10/-	6R7	6/-	12J5GT	3/-	78	5/-	5684	80/-	ACT6	170/-	E1T	55/-	EL85	8/-	PCC88	10/6	U12/14	8/-	CV289	40/-
1X2B	7/-	6AQ5	6/-	6R7	6/-	12J5WGT		80	6/-	5687	8/-	ACT9	200/-	E88CC	14/-	EL86	7/6	PCC89	10/-	U17	5/-	CV359	10/-
2A3	5/-	6AQ6	8/-	6SH7	3/-		6/-	81	10/-	5691	25/-	ACT25		E90CC	12/10	EL90	6/-	PCC189	10/-	U22	6/-	CV406	15/-
2A4G	30/-	6AR5	6/-	6SJ7	8/-	12J7GT	7/6	83	8/-	5696	6/-		500/-	E91H	12/-	EL91	2/6	PCF80	6/-	U25	11/-	CV473	12/6
2C26	3/-	6AR6	6/-	6SK7	5/-	12K7GT	7/-	83V	7/6	5718	7/6	AH211A		E92CC	7/-	EL360	22/-	PCF82	7/-	U26	11/-	CV570	
2C34	4/-	6AS6	5/-	6SL7GT	5/-	12K8	10/-	84	5/-	5725	10/-		240/-	E180CC	8/-	EL821	6/-	PCF84	8/-	U50	5/-		700/-
2C39A	80/-	6AS7G	22/6	6SN7GT	4/6	12Q7GT	5/-	85A1	25/-	5726	7/-	AR8	6/-	E180F	15/-	EL822	8/-	PCF86	8/-	U76	4/-	CV1029	30/-
2C40	70/-	6AT6	4/-	6SR7	8/-	12SA7	7/-	85A2	8/6	5727	10/-	ARP3	3/-	EA50	2/-	EM31	5/-	PCF801		U191	11/-	CV2203	
2C42	25/-	6AU6	6/-	6SS7	3/-	12SC7	4/-	85A3	5/6	5749	9/-	ARP12	3/6	EAB/C80	6/-	EM34	9/6		10/-	U251	12/6		200/-
2C43	60/-	6AV6	6/-	6U4GT	10/6	12SF5GT		90CG	20/-	5750	11/-	ATP4	5/-	EAC91	4/-	EM80	6/6	PCF802		U281	13/-	CV2209	10/-
2C46	30/-	6B7	5/-	6U5	8/-		9/-	90CV	17/6	5751	11/-	AW6	5/-	EAF42	8/6	EM81	7/6		10/-	U282	14/-	CV2231	18/-
2C51	12/-	6B8	5/-	6U7G	7/-	12SG7	4/-	150B2	12/-	5763	10/-	AZ1	9/-	EB41	5/-	EM84	8/-	PCF806		U301	12/-	CV2248	20/-
2C52	12/-	6B8G	2/6	6U8	7/6	12SH7	4/-	150B3	8/-	5783WB	5,6	AZ12	9/-	EBC33	7/-	EM85	9/-		13/-	U403	7/-	CV2249	20/-
2CW4	12/-	6BA6	4/9	6V6	9/-	12SJ7	4/-	211	30/-	5787	10/-	AZ31	8/-	EBC41	7/-	EM87	7/-	PCL81	9/-	U801	18/-	CV2250	20/-
2D21	6/-	6BE6	5/-	6V6G	5/-	12SK7	5/-	225DU	10/-	5814A	10/-	AZ41	6/6	EBC81	6/6	EN31	10/-	PCL82	6/6	U4020	7/6	CV2251	20/-
2E22	25/-	6BF6	6/-	6V6GT	7/6	12SL7GT		262B	30/-	5840	10/-	B61H	15/-	EBF80	6/6	EN32	10/-	PCL83	8/3	UABC80		CV2252	20/-
2E24	40/-	6BH6	7/-	6X4	4/-		7/6	313C	30/-	5842	65/-	B65	4,6	EBF83	7/6	EY51	7/-	PCL84	7/-		5/6	CV2253	20/-
2E26	30/-	6BJ6	8/-	6X5GT	5/6	12SN7GT		416B	200/-	5845	30/-	BD78	45/-	EBF89	6/9	EY70	12/6	PCL85	9/-	UAF42	8/-	CV2277	20/-
2G21	12/-	6BJ7	7/-	6Y6G	6/-		7/6	417A	65/-	5852	20/-	BL63	10/-	EBL1	14/-	EY81	8/-	PCL86	9/-	UBC41	6/6	CV2303	
2X2	3/-	6BK4	20/-	6Z3	4/-	12SQ7	10/-	583	40/-	5949	400/-	B34A	30/-	EBL21	11/-	EY83	9/6	PEN4A	7/6	UBC81	7/-		800/-
2X2A	7/-	6BK7A	8/-	6Z4	5/-	12SR7	5/-	705A	10/-	5963	10/-	B36104	400/-	EC52	12/6	EY84	7/6	PEN45	7/-	UBF80	6/6	CV4006	18/-
3A4	4/-	6BL7GT	9/-	7B6	11/-	12SY7	6/-	715A	30/-	5965	5/-	BT5	50/-	EC53	12,6	EY86	6/-	PEN45DD		UBF89	7/-	CV4007	7/-
3A5	7/-	6BN6	7/-	7B7	8/-	12Y4	2/6	715B	60/-	5993	12/-	BT9A	60/-	EC85	8/-	EZ35	5,6		12/-	UBL21	11/-	CV4010	8/-
3B7	5/-	6BQ7A	8/-	7C5	10/-	13D1	5/-	715C	70/-	5998	15/-	BT19	30/-	EC86	12/-	EZ40	5,6	PEN46	6/-	UCC84	6/-	CV4014	8/-
3B22	30/-	6BR7	11/6	7C6	7/-	13D3	6/-	717A	4/-	6005	7/6	BT45	200/-	EC90	2/6	EZ41	6,6	PEN220A		UCC85	6/6	CV4033	7/-
3B24	5/-	6BR8	5/-	7C7	5/-	13E1	190/-	721B	25/-	6021	12/-	BT79	30/-	EC91	5/-	EZ80	5,6		7/-	UCF80	9/6	CV4037	7/6
3B24W	12/-	6BS7	16/-	7E5	5/-	14E6	6/-	801A	6/-	6058	7/-	BT83	60/-	EC92	6/6	EZ81	4,6	PEN384		UCH21	8/6	CV4038	5/6
3B28	20/-	6BW6	9/-	7E6	4/-	15E	8/-	803	30/-	6059	17/-	C1C	5/-	ECC31	5/-	FA13	120/-		12/-	UCH42	7/6	CV4043	12/-
3C45	30/-	6BW7	9/-	7E7	10/-	19AQ5	5/-	804	70/-	6060	6/-	C3JA	80/-	ECC32	4/-	FVD7	15/-	PEN453DD		UCH81	7/-	CV4044	7/6
3CX100A5		6C4	2/6	7F8	8/6	19BG6G	7/-	805	30/-	6061	12/-	CBL1	15/-	ECC40	9/-	FW4/800			10/6	UCL82	8/-	CV4045	10/-
	100/-	6C5G	5/-	7H7	8/-	19E2	20/-	807	9/-	6064	8/-	CL33	9/-	ECC81	4/-		8/6	PF86	7/6	UCL83	10/-	CV4052	8/6
3D6	4/-	6C5GT	6/-	7R7	12/-	19G3	25/-	809	40/-	6067	10/-	CY31	6/6	ECC82	5/-	C24H	15/-	PL36	8/6	UF41	7/6	CV4053	8/6
3E29	60/-	6C6	4/-	7S7	16/-	19G6	15/-	811	20/-	6072	15/-	D1	3/-	ECC83	6/-	GC10/4B		PL38	16/-	UF42	7/6	CV4054	12/-
3Q4	6/6	6C8G	7/-	7Y4	7/-	20A2	20/-	812A	45/-	6073	7/6	DA30	10/-	ECC84	6/6			PL81	7/-	UF80	6/6	CV4055	12/-
3Q5GT	6/6	6C21	100/-	7Z4	5/-	20F2	15/-	813	70/-	6080	25/-	DA41	40/-	ECC85	6/6	GT1C	10/-	PL82	5/6	UF85	7/-	CV4058	10/-
3S4	5/-	6CB6	5/-	8D2	3/6	20L1	14/-	814	20/-	6094	25/-	DA250	500/-	ECC88	10/-	GU50	25/-	PL83	6/-	UF86	10/-	CV4059	7/6
3V4	5/6	6CD6G	17/-	9BW6	7/-	20P1	14/-	815	40/-	6098	12/-	DAC32	7/-	ECF80	7/6	GZ30	8/6	PL84	6/6	UF89	6/-	CV4062	
4D1	4/-	6CH6	6/-	9D7	7/-	20P3	12/-	829B	60/-	6100	10/-	DAF70	7/-	ECF82	7/6	GZ32	10/-	PL500	15/-	UL41	7/6		17/6
4E27	60/-	6CL6	9/-	10C1	10/-	20P4	14/-	832	20/-	6101	7/-	DAF91	4/6	ECF86	11/-	GZ34	10/-	PM84	10/-	UL84	6/-	CV4063	10/-
4PR60A		6CW4	12/-	10C2	12/-	20P5	12/-	832A	45/-	6111	15/-	DAF92	6/-	ECH21	10/-	GZ37	9/-	PT15	10/-	UM80	7/-	CV4067	10/-
	240/-	6CY5	10/-	10D1	7/-	25A6G	5/-	838	12/-	6130	30/-	DAF96	6/-	ECH35	12/-	HL2	3/-	PY31	7/-	UU5	8/-	CV4069	6/-
4THA	14/-	6D3	7/6	10F1	14/-	25L6GT	8/-	860	10/-	6135	10/-	DC70	8/-	ECH42	8/-	HL2K	3/-	PY33	9/-	UU7	8/-	CV4071	15/-
4OX1000A		6D4	15/-	10F9	9/-	25Z6G	7/-	866A	14/-	6136	9/-	DCC90	7/-	ECH81	6/-	HL23	6/-	PY81	5/6	UU9	7/-	CV4501	5/6
	500/-	6D6	3/-	10F18	10/-	25Z5	7/6	872A	35/-	6140	30/-	DET15	10/-	ECH83	7/6	HL23DD	6/-	PY82	5/-	UU10	8/-	CV4502	5/6
5C22	120/-	6DK6	6/-	10L1	7/6	25Z6GT	8/6	884	15/-	6146	27/6	DET12	40/-	ECL80	6/6	HR2	15/-	PY83	6/-	UY21	8/-	CV4503	5/6
5D21	70/-	6DS4	15/-	10LD11	10/-	27M1	60/-	931A	60/-	6147	17/-	DET18	40/-	ECL82	7/6	HR7	15/-	PY88	8/6	UY41	5/6	CV4505	15/-

Our new price list of Valves, Tubes and Semiconductors is now ready. Please send 6d. stamp or 6d. stamped addressed quarto envelope.

When ordering by mail, please add 2/6 in £ to cover handling and postage. **MINIMUM CHARGE 1/6. NO C.O.D. orders accepted.**

WE WISH TO BUY VALVES, KLYSTRONS, MAGNETRONS, etc. Please offer us your surplus stock.

Z. & I. AERO SERVICES LTD.

RETAIL BRANCH: 85 TOTTENHAM COURT ROAD, W.2. Tel: LANgham 8403

Please send all correspondence and Mail Orders to OUR NEW ADDRESS OF HEAD OFFICE AT:
44a WESTBOURNE GROVE, LONDON, W.2. Tel: PARk 5641/2/3
(No personal callers are served at 44a Westbourne Grove except genuine trade orders.)

14WW—154 FOR FURTHER DETAILS.

ERSIN Multicore SOLDER

NEW!

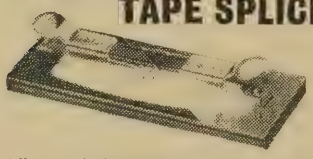
PRINTED CIRCUIT & TRANSISTOR SOLDER

Designed specifically for Printed Circuits and High Temperature Sensitive Components. Plastic re-usable reel contains 250 feet of 60/40 High Tin Quality 22 s.w.g. ERSIN MULTICORE SOLDER with 5-cores of non-corrosive flux. Ask for Size 10.

15/- each (Subject)

* For small users, the same specification is available on a 2/6d. reel (subject).

Bib THE PROFESSIONAL TAPE SPLICER



All metal—beautifully plated—compact in size. Easily and permanently attached to a tape recorder. Clamps hold the magnetic or leader tapes in the precision cut channel—no damage to the edges. Right angle and oblique cutting slots.

Complete with Razor Cutter 18/6

Bib WIRE STRIPPER AND CUTTER

This efficient tool strips insulation, cuts wires cleanly and splits plastic twin flex. It is adjustable to most wire thicknesses.

3/6 each (Subject)

If you have any difficulty in obtaining these items they will be sent post free.

MULTICORE SOLDERS LTD.
HEMEL HEMPSTEAD, HERTS.
TEL: BOXMOOR 3636

(See also advertisement on back cover)

14WW—155 FOR FURTHER DETAILS.

TRANSISTORS THEORY AND CIRCUITRY

by
K. J. Dean

35/- Postage 1/-

TRANSISTOR IGNITION SYSTEMS HANDBOOK, by B. Ward. 20/-. Postage 6d
AN ELECTRONIC ORGAN FOR THE HOME CONSTRUCTOR, by A. Douglas. 20/-. Postage 9d.
ELECTRONIC TEST INSTRUMENT HANDBOOK, by G. A. Risse. 35/-. Postage 1/-.
ELECTRONIC MEASUREMENTS, by F. E. Terman and J. M. Pettit. 42/6. Postage 1/3.
AN INTRODUCTION TO COUNTING TECHNIQUES AND TRANSISTOR CIRCUIT LOGIC by K. J. Dean. 25/-. Postage 1/-.
INTER G.E.C. S.C.R. MANUAL. 3rd Ed. 16/6. Postage 1/3.
TRANSISTOR CIRCUIT DESIGN by Texas Instruments Inc. 120/-. Postage free.
ELECTRONIC MUSICAL INSTRUMENTS by R. H. Dorf. 60/-. Postage 1/6.
REFERENCE MANUAL OF TRANSISTOR CIRCUITS by Mullard. 12/6. Postage 1/-.
COMPLETE CATALOGUE 1/-.

THE MODERN BOOK CO.

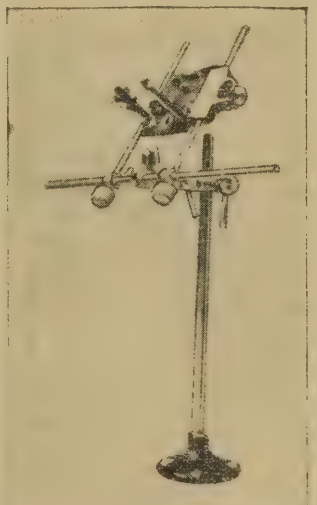
BRITAIN'S LARGEST STOCKIST
of British and American Technical Books

19-21 PRAED STREET
LONDON, W.2

Phone: PADdington 4185
Open 6 days 9-6 p.m.

"SPEARETTE"

PRINTED CIRCUIT SERVICING RACK



THE ELECTRONIC ENGINEER'S THIRD HAND WHEN ASSEMBLING OR SERVICING PRINTED CIRCUIT PANELS.

FULL ADJUSTMENT IN ALL PLANES

Details of this and other aids:

SPEAR ENGINEERING CO. LTD.
WARLINGHAM, SURREY
Tel.: Upper Warlingham 2774

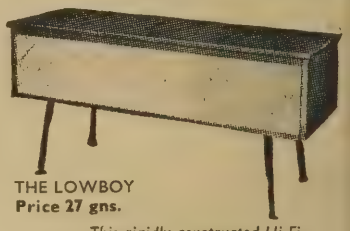
14WW—156 FOR FURTHER DETAILS.

CABINETS AT SENSIBLE PRICES FROM

£5 . 17 . 6d!

You can be sure of meeting the exact cabinet you require when you examine the most extensive range in the country at Lewis Radio, here are just two examples:

THE BRAHMS
Price 27 gns.
This new elegant Brahms cabinet is available in medium walnut and medium mahogany with 9in. legs and will take any tape deck, turntable, tuner and pre-amplifier, the largest stereo amplifier plus record and tape storage.



THE LOWBOY
Price 27 gns.
This rigidly constructed Hi-Fi cabinet will accommodate even the largest Hi-Fi units—available in teak, walnut or stripey sapele mahogany—size 53in. long by 18in. deep by 26in. high including 12in. legs.

FREE · **THE NEW LEWIS CATALOGUE**

Designed to assist your choice of cabinet

THE new Lewis Radio Cabinet Catalogue—the most comprehensive ever prepared. Sent absolutely Free.

Please send your free 24-page colour cabinet catalogue.

NAME .....

ADDRESS .....

.....(Dept. W 1164)

CAPITALS PLEASE

LEWIS radio

10[illegible] CHASE SIDE, SOUTHGATE, LONDON, N.14
Telephone: Palmers Green 3733/9666

14WW—157 FOR FURTHER DETAILS.

CLASSIFIED ADVERTISEMENTS

Rate 9/- for 2 lines or less and 4/6 for every additional one or part thereof, average lines 6 words. Box Numbers 2 words plus 1/-. (Address replies: Box 0000 c/o "Wireless World" Dorset House, Stamford St., London, S.E.1.) Trade discount details available on application. Press Day December 1964 issue, Friday, November 13th. No responsibility accepted for errors.

SITUATIONS VACANT

D.S.I.R.

HYDRAULICS Research Station, Wallingford, Berks.

ASSISTANT Experimental Officer for design development construction and maintenance of instruments, including equipment for analogue and digital recording of water level, temperature and conductivity force, pressure and displacement. Work mainly electronic but partly mechanical.

QUALIFICATIONS: age preferably 22-25. H.N.C. degree or equivalent. Experience of circuit design and construction for d.c. and l.f. amplifiers, control and switching circuits desirable.

SALARY: £712 (at age 22)—£884 (at age 26 or over)—£1,085. Housing available for married staff.

APPLICATION Form from the Director at the above address quoting E/AL/023. [1050

TECHNICAL CIVIL SERVICE.

HOME OFFICE COMMUNICATIONS BRANCH invites applications for WIRELESS TECHNICIAN posts at Regional Wireless Depots in England and Wales for installation and maintenance work on v.h.f. and u.h.f. communications systems for Police, Fire and Civil Defence services.

SALARY: £792 at age 21, rising to £929 at age 25 (this being the highest rate payable on entry), increasing to a maximum of £1,067 by annual increments.

QUALIFICATIONS AND EXPERIENCE: Applicants, who must be natural born British subjects between 21 and 40, should have a sound and up-to-date knowledge of radio theory and practice, preferably supported by relevant Ordinary National or City and Guilds Certificates. Experience of v.h.f. or u.h.f. equipment would be an advantage.

PROSPECTS: All appointments will be in an unestablished capacity in the first place but there are reasonable prospects of establishment and promotion to Senior Wireless Technician (£1,091-£1,285) and Chief Wireless Technician (£1,244-£1,539). Opportunities for further technical education will normally be available. Further particulars and application forms are obtainable up to 27th Nov., 1964, from Communications Branch, Home Office, Whitehall, London, S.W.1. Interviews will be in London. [1046

RADIO & Television Testers.

FOR City Factory; good rates up to 7/6 per hour; five-day week.

APPLY to Personnel Manager:—

ALBA (RADIO & TELEVISION), Ltd., Tabernacle St., London, E.C.2. [0012

AN OVERSEAS CAREER WITH

INTERNATIONAL AERADIO LIMITED.

TO meet the requirements of constant growth and expansion we invite applications from technicians and engineers for an overseas career in North, West and East Africa, the Mediterranean area, the Caribbean, the Arabian Gulf and the Far East. If you have recently completed service in a trade such as Ground Wireless Fitter in the R.A.F. or Radio Electrical Artificer in the Royal Navy or have other experience in the maintenance of HF and VHF communications, RTT and navigational aids, we should be interested to hear from you. Successful candidates would normally spend six weeks at our Radio Training School, Southall, Middlesex, before proceeding overseas, but in some cases staff with suitable qualifications and experience may be offered immediate posting. Overseas staff receive a tax-free salary with married and child allowances if appropriate and accommodation, bachelor or married, is provided free; other benefits include generous U.K. leave and membership of an excellent pension and life assurance scheme.

WRITTEN applications, please, to Personnel Officer, 40, Park St., W.1. [0084

THE UNIVERSITY OF SOUTHAMPTON.

ELECTRONIC TECHNICIAN

REQUIRED for the Audiology Group of the Institute of Sound and Vibration Research to build and maintain equipment used in studies of hearing. Experience in circuitry desirable. Salary £580-£815 according to qualifications and experience. Superannuation, good holidays. Applications in writing, stating experience and the names of two referees, to the Secretary and Registrar (Room 9), The University, Southampton, as soon as possible. [1038

RADIO AND ELECTRICAL MECHANICS

REQUIRED for interesting and varied work overhauling Aircraft Components. Generous rates of pay including sick pay, pension and free insurance.—Apply Skyways Engineering Limited, Stansted Airport, Stansted, Essex. [1042

IBM needs ELECTRONIC ENGINEERS and ELECTRO-MECHANICAL ENGINEERS

Because of our expansion into new fields of Data Processing —Data Collection and Transmission via conventional communications facilities—our Product Engineering Department requires ELECTRONIC ENGINEERS and ELECTRO-MECHANICAL ENGINEERS, with a good general engineering background, who are capable of preparing and maintaining from development documents, the manufacturing data required for the production of electronic and electro-mechanical units in our new product lines.

These activities include detailing assembly methods and testing procedures, specifying test equipment design requirements, evaluating components and generally providing technical support to production departments. Although the basic design work is carried out in IBM Development Laboratories, applicants for Electronics positions must be capable of understanding transistor logical circuits, and applicants for Electro-Mechanical positions must be capable of understanding light electro-mechanical mechanisms and associated electrical circuitry. All must be able to communicate problems and recommend design corrections and improvements to development.

In addition to a challenging job, IBM Greenock offers a location in magnificent surroundings free from commuting, and with excellent facilities for leisure time activities. Sailing, fishing, golfing, water ski-ing, etc.

If you are aged 40 or under, with qualifications to Degree or HNC level (lesser qualifications are acceptable if coupled with suitable industrial experience) and are interested in the above situations, please write giving full details of background, experience and qualifications to:—

Personnel Manager,
IBM United Kingdom Limited,
P.O. Box 30,
Spango Valley,
Greenock, Scotland.
Quoting Reference ENG/WW/932

IBM
IBM IS EXPANDING

ELECTRONIC ENGINEERS

are required by

W. H. ALLEN SONS & CO. LTD., BEDFORD

for their

LABORATORY

The Company is engaged on the manufacture of steam turbines, diesel engines, electrical machinery and pumps, and vacancies exist for Engineers who are interested in and have some experience in the following fields:

(1) The use of a wide range of electronic equipment to carry out special tests on mechanical and electrical machinery. Examples include the use of oscilloscopes, noise and vibration analysers, strain gauge equipment, etc. The work is essentially practical.

(2) The development of special electronic methods of measurement for both routine and research applications. The work requires the designing and testing of transducers and associated equipment.

(3) The design, development and testing of servo-control systems for electrical and other machines.

Qualifications required for (1) are not less than an H.N.C., whilst (2) and (3) require not less than a Diploma of Technology, but these requirements may be waived in the case of applicants with a proven history of success in these fields. In all cases the ability to write clear, concise reports is essential.

Write for application forms and conditions of service indicating the field in which you are interested to: The Personnel Manager (Ref. 801/4), Queens Engineering Works, Bedford.

TESTERS

required for interesting work on L.F. and H.F. Transmitters. Previous fault-finding experience essential.

The positions available would be of special interest to persons employed in the fault-finding and repair of television who are keen to establish themselves in a position that offers:

- ★ Satisfactory employment
- ★ Five-day week
- ★ Good prospects of advancement
- ★ Staff status
- ★ Sick pay
- ★ Generous salary

Apply: Personnel Manager

Multitone Electric Co. Ltd.
12-20 Underwood St., London, N.1

REDIFFUSION TELEVISION LTD.

HAVE vacancies for Technical Assistants with ELECTRONIC QUALIFICATIONS at least equivalent to H.N.D. with Electronic Endorsements. Starting salary £1,050.—Apply in writing to (A.G.M. Staff), Rediffusion Television Ltd., Television House, Kingsway, London, W.C.2. Marking Envelope ENG. [1053

HI-FI manufacturers/dealers, London, N.W., require qualified Engineer with sales ability. Comm. salary £1,000 p.a. plus commission on gross turnover.—Box WW 1036, Wireless World.

RADIO components, assistant wanted for shop and mail-order, excellent prospects for the right applicant.—Apply in writing first to: Home Radio (Mitcham), Ltd., Mitcham, Surrey. [1033

Ministry of Defence (Air Force Department) have vacancies for **CIVILIAN RADIO TECHNICIANS** at R.A.F. Sealand, Cheshire; R.A.F. Cosford, Staffordshire and other R.A.F. stations throughout the United Kingdom for the servicing, repair, modification and testing of air and ground radio and radar equipment. Commencing salary according to age is £722 rising to £929 p.a., max. salary £1,067 p.a. Houses may be available for renting at West Kirby some 15 miles from Sealand. Apply to **Ministry of Defence (CE3h (Air)), Sentinel House, Southampton Row, W.C.1,** or to any Employment Exchange.

RADIO TECHNICIAN

A number of suitably qualified candidates will be required for training, leading to permanent and pensionable employment. (Normally at Cheltenham but with opportunities for service abroad or appointment to other U.K. stations.)

Applicants must be 19 or over and be familiar with the use of Test Gear and have had Radio/Electronic workshop experience. They must offer at least "O" level G.C.E. passes in English Language, Maths. and/or Physics, or hold the City and Guilds Telecommunications Technician Intermediate Certificate or equivalent technical qualifications.

Pay according to age, e.g., at 19, £722; at 25, £929 (highest pay on entry) rising by four increments to £1,067.

Prospects of promotion to grades in salary range £997–£1,634.

Annual leave allowance of 3 weeks, 3 days, rising to 4 weeks 2 days.

Normal Civil Service sick leave regulations.

Apply:
Recruitment Officer (RT/3),
Government Communication
Headquarters,
Oakley, Priors Road, Cheltenham.

TELEVISION SERVICE ENGINEERS

- **5 day week (London) 42 hours**
- **Good basic wage plus**
- **Merit pay**
- **Paid over-time**
- **Sickness Benefit and Superannuation**
- **Good prospects**
- **Encouragement given and opportunity available for further Technical Education.**

Vacancies—South East Region—London all parts, Basildon, Harlow, Weybridge, various parts Kent, Reading. Clean driving license essential. All interviews arranged locally.

Ex-Service Radar Fitters particularly invited to apply.

Don't stagnate, join an expanding Company.

RENTASET LIMITED

Apply: **Regional Engineer, Rentaset Limited, 27, Clarendon Road, Harrow, Middlesex.** Tel.: HAR 6661

RADIO TECHNICIAN

required immediately for
OCEAN WEATHER SHIPS
with a sound knowledge of at least three of the following types of equipment:—

Single Side-Band Transmitter, Radar (Navigational), Radar Height Finding, Echo Sounders and Radio Receivers, Automatic D.F., V.H.F. and M.G. Low Voltage Servo Recorders. Digital Telemetering Equipment. Salary scale £655-£1,067 per annum according to age, plus £120 per annum overtime allowance. Free food and accommodation provided on board ship. Applicants must be natural born British subjects. Full details from Shore Captain, Ocean Weather Ship Base, Great Harbour, Greenock. Telephone Greenock 24291.

SCOTTISH TELEVISION LTD.

We have vacancies in our Sound Department in Glasgow and if you meet with the following requirements, we would like to hear from you.

★ S.C.E. Higher grade or G.C.E. " A " Level and O.N.C., H.N.C. or equivalent qualification.

★ Thorough knowledge of basic Sound and Electronic theory.

★ Experience in the operation and maintenance of Sound Equipment in Television Studios would be an advantage.

The salary will either be £978 per annum or £1,163 p.a. dependent on qualifications and experience. The conditions of employment are good.

Applications, in writing, should be sent to Personnel and Labour Relations Officer, Scottish Television Ltd., Theatre Royal, Hope Street, Glasgow.

TELECOMMUNICATIONS ENGINEERS

REQUIRED by the GOVERNMENT OF NORTHERN RHODESIA, G.P.O. Department, for service as Technical Officers on contract for one tour of 36 months in the first instance. Commencing salary according to age and experience in scale rising to £1,580 a year. ENHANCED GRATUITY WHICH IS NOW AT THE RATE OF 25% OF TOTAL SALARY DRAWN. Free passages. Liberal leave on full salary. Accommodation provided at low rental. Children's education allowances.
CANDIDATES, 22-45 years of age, should possess at least one City and Guilds Certificate and have had a minimum of 2 years training with at least 2 years subsequent practical experience in the installation and maintenance of one of the following branches of telecommunications engineering:—
(i) AUTOMATIC and Manual Exchanges.
(ii) SUBSCRIBERS Apparatus, P.B.X. and P.A.B.X.
(iii) CARRIER Equipment.
(iv) OVERHEAD lines, trunk and local cables.
(v) TELEPRINTER Equipment.
APPLY to CROWN AGENTS, M Dept., 4 Millbank, London, S.W.1, for application form and further particulars, stating age, name, brief details of qualifications and experience, and quoting reference M2E/52145/WF. [1039

WAR DEPARTMENT, 33, Central Workshop, Reme, Newark, Notts.
TELECOMMUNICATIONS mechanics for overhaul of wireless equipment, starting range of pay £12/6 to £13/8; progression beyond this according to service and qualification; five-day 42-hour working week, opportunities for external training and promotion.—Apply to Officer Commanding, 33 Central Workshop R.E.M.E., Lincoln Rd., Newark, or local office the Ministry of Labour, quoting reference 33/CW/1. [0167

TV service engineer required, good pay, 5-day week, 3 weeks' holiday with pay.—Singer's Radio, Ltd., 261, Harrow Rd., London, W.2. Cunningham 0707. [0271

TELEVISION and radio skilled bench and field engineers required, good rates of pay plus bonus; maisonette available.—Home Electrics, Ltd., Central Service, 15, Oxford Walk, Southall. Tel. Southall 4367. [1051

INSTRUCTOR in marine radar required by the College of I.M.R.Commns., Brooks' Bar, Manchester 16, to commence Jan., 1965. Applicants must hold the M.o.T. Radar Maintenance Cert., and should also have had radar experience as a marine Radio Officer and/or service engineer.—Apply Principal, giving in confidence full details of experience, education, present salary, etc. [1031

PROFESSIONAL ENGINEERS AND TECHNICIANS

with at least 2 years experience in British Industry are invited to avail themselves of our Confidential and Free Service.

E.A.L. offers the most efficient and satisfactory way of obtaining alternative employment in the Electronics Industry.

E.A.L. is in contact with all firms in S.E. England and undertakes a complete and thorough survey of any area for suitable vacancies for every engineer registered with us.

For further information please phone or write to:—

ELECTRONICS APPOINTMENTS LTD.,
22 Gloucester Mansions,
Cambridge Circus,
London, W.C.2.
TEMple Bar 5557-8

PYE CAMBRIDGE WORKS Ltd., Haig Rd., Cambridge.
* SINGLE sideband equipment.
* VHF radiotelephone equipment.
* HI-FI reproduction equipment.
WE require trained personnel for production testing and fault finding of modern equipment.
WE have limited vacancies for more senior and experienced men with drive, who can lead small teams engaged on this work.
We have also limited vacancies for persons of less experience who can be trained or such work
APPLY to: The Personnel Manager. [0340

ENGINEER wanted with clean driving licence experienced in the operation and maintenance of 16mm film projection equipment, knowledge of audio/amplification equipment useful but not essential.—Box WW 1032, Wireless World.

ELECTRONIC Test Engineers are required by firm manufacturing scientific instruments. Minimum qualification of O.N.C. is essential. Excellent promotion prospects.—Apply to Personnel Officer, Electronic Instruments Ltd., Richmond, Surrey. [1043

TEST Engineers: required for the testing of electronic instruments, some previous test-room experience desirable. Permanent positions with good salaries.—Watford Control Instruments, Ltd., Riverside Rd., Watford. Tel. Watford 41313. [1047

SENIOR Test Supervisor required for leading radio and television manufacturer, Esssx. This is a permanent appointment at substantial salary and applicants should have had at least five years previous experience in a similar capacity.—Apply Box WW1040, Wireless World.

A VACANCY occurs in the electronic dept. of a well-known photographic importer, E.C.1 area. Applicants should have basic knowledge of electrical and radio theory and preferably some experience of radio or similar work. Good conditions, 5-day week and L.V.s.—Apply: CLE 8031 for appointment. [1030

ELECTRONIC Technician required in Department of Physiology for construction, testing, maintenance of electronic equipment. Mechanical ability and an interest in T.V. servicing an advantage. Salary scale £700—£860, plus London Weighting.—Applications to: The Secretary, Middlesex Hospital Medical School, London, W.1. [1037

A E E

ATOMIC ENERGY ESTABLISHMENT WINFRITH

Electronic/Instrument Mechanics

A.E.E. Winfrith require craftsmen with a knowledge of electronic equipment and/or industrial instrumentation for fault diagnosis, repair and calibration of a wide range of instruments used in nuclear reactors and associated experiments.

Men with Services, Industrial or Commercial background of radar, radio, television, industrial or aircraft instruments are invited to write for further information. Training in Specialised Techniques is provided for successful applicants.

Married men living beyond daily travelling distance will be eligible for housing. A lodging allowance is payable whilst waiting for housing. Working conditions are good and include sick pay and pension schemes.

Applications to
Selection Officer,
A.E.E. Winfrith,
Dorchester,
Dorset,
quoting ref. EL/INST/SK.

FANTASTIC TAPE OFFER (G'nteed).
7" STD. 1200' 8/6 empty reel 2/6
5½" STD. 900' 6/9 empty reel 2/3
5" STD. 600' 6/- empty reel 2/-
3" STD. 175' 2/6 empty reel 1/-
POST FREE.
S.A.E. for lists of L/P and D/P tapes.
A. Marshall & Son.
28 Cricklewood Bdy,
London, N.W.2.
Telephone: GLA 0161/2

14WW—158 FOR FURTHER DETAILS.

TECHNICAL TRADING CO.
11/12 NORTH RD., BRIGHTON
TEL.: 67999
VALVES— All items as advertised in the May issue still available.
Other Retail Shops:- 72 East Street, Southampton & 350 Fratton Road, Portsmouth

Telecommunications Ltd. Ditton Works, Newmarket Road, CAMBRIDGE.

REQUIRE

TEST ENGINEERS for production and Systems Testing of VHF, UHF, and Microwave Radio Telephone Equipments.

INSPECTORS who have had previous experience of electronic inspection work. This would suit men who have trained in the Services.

VHF SERVICE ENGINEERS for our London and Provincial Service Depots throughout the country. Good rates of pay and working conditions.

APPLY TO

The Personnel Manager. Teversham 3131

ELECTRONIC TESTERS

required

to work on H.F. and V.H.F. equipment, Data Transmission and Telegraph systems.

Apply for full details to:—

Personnel Officer,

A.T. & E. (Bridgnorth) Ltd.

Bridgnorth, Shropshire.

TECHNICAL Assistant (aged 22-25) with basic knowledge of electronic valves and semi-conductor devices, required by trade association. Ability to record accurately and compile reports also necessary.—Apply in writing to: The Secretary, BVA/VASCA, Mappin House, 156-162, Oxford St., London, W.1. [1034

RADAR and RADIO ENGINEERS and MECHANICS with specific workshop experience X Band—AIRCRAFT WEATHER RADAR or U.H.F.; 40-hour week, salary according to experience and ability; pension scheme.—Apply: Managing Director, Air Transport (Charter) (C.I.), Ltd., Willow Rd., Poyle Trading Estate, Colnbrook, Slough, Bucks. [1016

TEST engineers.—Applications are invited from test engineers with previous industrial experience of testing radio communications, receivers and transmitters; successful applicants will be offered positions on the company's permanent staff; starting salaries commensurate with qualifications and experience.—Apply in writing, giving full details, to Personnel Officer, Redifon, Ltd., Broomhill Rd., S.W.18. [0252

BBC requires Assistant Draughtsmen/Technical Illustrators in Engineering Training Department. Duties include the production of original illustrations for use in Technical Instructions. Work consists mainly of the preparation of Indian ink circuit drawings based on rough sketches. Perspective drawings occasionally required and some routine office work involved. British subjects only. Salary according to age and experience in range £750 to £840 rising to £930 p.a.—Write for application forms to Engineering Recruitment Officer, Broadcasting House, Portland Place, W.1, quoting reference 64.E.4130. W.W. 1041, Wireless World.

TECHNICAL ASSISTANT (ELECTRONICS) required by the Department of Chemistry, University of Edinburgh. Applicants should have experience of modern methods of wiring and construction and the ability to locate faults on sophisticated electronic equipment. Qualifications to at least O.N.C. level, or equivalent. Special consideration may be given to applicants with previous experience of pulse circuitry. Salary in range £700-£900 per annum depending on age and experience. The appointment is initially for three years. Applications, giving full particulars and quoting reference No. TA./C/10/64, should be sent to The Secretary to the University, University of Edinburgh, Old College, South Bridge, Edinburgh. [1052

SITUATIONS WANTED

COMMUNICATIONS installation technician with experience in Africa and the Middle and Far East seeks position.—Box WW 24, Wireless World.

Field & Bench Television Service Engineers Required in West Middx for New Service Dept. Excellent Salary & Prospects offered to the Right Men. Unfurnished Flats Available.
Telephone **Mr. Perrini** — *West Drayton 3036*
OR Call at—
COXHEAD SERVICES LTD.
147, HIGH STREET
YIEWSLEY, MIDDX.

THE MINISTRY OF DEFENCE (ARMY DEPARTMENT) invites applications for interesting Grade V Engineering appointments in the BRITISH FORCES BROADCASTING SERVICE overseas in Aden, Benghazi, Tobruk, Tripoli and Cyprus.

DUTIES AND QUALIFICATIONS Operation and maintenance of MF, HF, VHF, Transmitters, Studio equipment and generating equipment. Appropriate ONC, City & Guilds, or equivalent qualifications are necessary.

SALARY SCALE (under review) for Grade V staff is £739 to £1,039 p.a. In addition generous non-taxable Foreign Service Allowances are paid according to location. Candidates must be at least 21 years of age on 1st, September, 1964.

For further details and Application Form please write to:—

The Director,
British Forces Broadcasting Service,
Kings Buildings,
Dean Stanley Street,
London, S.W.1.

CLOSING DATE 9th November, 1964

A.B. METAL PRODUCTS LIMITED
ABERCYNON, GLAM.

Manufacturers of UHF/VHF television tuners, amplifiers, aerials, potentiometers, switches and professional class connectors require:—

ELECTRONIC ENGINEERS AND TECHNICIANS
for interesting work on design, development and maintenance of a variety of electronic equipment, covering audio frequencies to 1000 Mc/s.

Applicants should have experience in one or more of these or allied fields. Outstanding opportunities exist for engineers with initiative, ability and drive, who are able to work with minimum supervision, and to carry projects through from the design conception to the production stages. Attractive salaries according to qualifications and experience.

TEACHING IN TECHNICAL COLLEGES

Applications are invited from graduates and from suitably qualified persons between 25 and about 45 to train to become teachers in mathematics engineering, physics, chemistry, metallurgy, food and catering, commerce and business studies, typewriting and shorthand, architecture and building, hairdressing, management studies, agriculture, printing, mining and natural sciences.

Tuition is free, personal and dependents' maintenance allowances are granted, and travelling expenses are paid.

Candidates should have good industrial or commercial experience and hold the Full Technological Certificate, Higher National Diploma or Certificate, or equivalent qualification.

Inquiries, quoting Ref. S27, to one of the following:

Director, Bolton Training College, Chadwick Street, Bolton.
Director, Huddersfield Training College, Holly Bank Road, Lindley, Huddersfield.
Principal, Garnett College, Downshire House, Roehampton Lane, London, S.W.15.
Principal, Wolverhampton Technical Teachers' College, Compton Road West, Wolverhampton.

BCC

ELECTRONIC ENGINEERS

required by the Communications Laboratories of a dynamic and growing Organisation. The work is varied and interesting and covers most aspects of Development and Engineering, for example—

1. Post Design Services, involving liaison with Sales and Production.
2. Anglicisation of overseas equipment, which includes liaison with organisations throughout the world.
3. Development of Military Equipment to DEF. 133 under Government Sponsorship.
   The ability to work with Government Research Establishments is very desirable.
4. Development of Commercial Equipment to specifications of various Overseas Government Departments. A knowledge of such requirements will be useful.
5. Environmental Testing and the preparation of Production Test Specifications. The ability to liaise with the Company's Production Test Department is highly desirable.

Applicants should have reached Degree or H.N.C. standard and/or should possess adequate industrial experience.

LABORATORY ASSISTANTS AND JUNIOR ENGINEERS are also required to work in the various groups listed above.

Excellent salaries will be paid commensurate with qualifications and experience and successful applicants will have every opportunity for advancement and promotion as a reward for hardwork, initiative an intelligent application.

Apply in first instance to:—**The Personnel Officer,**
British Communications Corporation Limited,
South Way, Exhibition Grounds,
Wembley, Middlesex.

BOOKS, INSTRUCTIONS, ETC.

WEBB'S log books for recording signals heard and worked, 112 pages, 9¾×8in, approved format, semi-stiff covers, excellent value 6/- post free, or callers 5/4.—Webb's Radio, 14, Soho St., London, W.1. [0021

WIRELES engineer magazines suitable new firm or library; early individual copies, bound vols. 1937-45, continuous copies unbound to about '61 and other magazines; offers.—Box W.W. 1024, Wireless World.

BOUND volumes (wine) Wireless World 1945-1955, in excellent condition; 30/- each o.n.o.; unbound copies 1956-1959 prepared for binding.—Offers to Aldridge, 10, Oakhill Rd. Ashtead, Surrey. [1044

NEW COMPONENTS

"WIRELESS WORLD" crystal controlled f.m. tuner, s.a.e. for itemised price list, test instruments and Mullard transistor amplifier lists also available.—Ajax Electronics, 18A, Rumbold Rd., Fulham, London, S.W.6. [22

LINE O.P. transformers and scan coils for most makes, exact replacements, from 25/- used and 50/- new, send s.a.e. for imm. quote, add 3/6 for p. & p.; telephone orders sent same day c.o.d.; examples; new LOPT's; Ekco T231/221, 65/-; Pye VT4/7, 59/6; Murphy V250/280, 65/-; Cossor 938, etc., 62/6; Ferguson 992-8, 69/6; Masteradio, 65/-; H.M.V. 1840-8, 65/-; Alba T321-4, etc., 52/6 used and 14/17 T/V's, callers only, £1 each.—T.C.S., Ltd., 112, Camberwell Rd., S.E.5. Tel. Rodney 7917. Open all day Saturday. [0334

RECEIVERS AND AMPLIFIERS—SURPLUS AND SECONDHAND

HRO Rx's, etc., AR88, CR100, BRT400, G209, S640, etc., etc., in stock.—R. T. & I Electronics, Ltd., Ashville Old Hall, Ashville Rd., London, E.11. Ley. 4986. [0053

AMERICAN TRANSISTORS

now available in this country with over 200 on our lists. All brand new and guaranteed, Data and circuits with all our items which include **MODULES** (solid state), **DIODES, SILICON RECTIFIERS, PAPER THIN CAPACITORS, etc.** All U.S. manufacture. Send 1/- for complete NEW reference catalogue with operating characteristics.

J. & J. ELECTRONICS
15 KENSINGTON HIGH STREET, LONDON, W.8.

14WW—159 FOR FURTHER DETAILS.

PULLIN

Precision Instruments & Components, Electro-Mechanical, Electronic and Optical Systems

TECHNICAL ASSISTANT

required for a section dealing with

SPECIAL TEST EQUIPMENT

and

TEST METHODS

The work which is interesting and varied, includes the analysis of test requirements and the Development of test units and set-ups, involving precision measurements of D.C. and of A.C. at low frequencies. Qualifications to at least O,N.C. standard. Salary according to age and experience. Please telephone or write for an appointment to: (Quoting ref: 514C)

PERSONNEL MANAGER,
R. B. Pullin & Co. Ltd.,
Great West Road, Brentford, Middlesex.
Telephone ISL 1212

THE DECCA NAVIGATOR CO. LTD.

require the services of a

SENIOR ELECTRONIC ENGINEER

for development work in their Omni-Trac Computer Laboratory. Experience of Digital Circuits essential, qualifications to degree standard would be an advantage.

The position carries an attractive salary and conditions of employment, and offers scope for advancement with an expanding Company famous throughout the world.

Please apply either in writing, in person or 'phone to the **Personnel Officer, The Decca Navigator Co. Ltd., 247 Burlington Road, New Malden, Surrey. MALden 2271.**

W. H. SMITH & CO.

ELECTRICAL ENGINEERS LTD

SERVICE DIVISION

REQUIRE SERVICE ENGINEERS

INDUSTRIAL CONTROL & INSTRUMENTATION
Applicants should be fully experienced in Field Service work of Temperature, flow, pressure, and gas analysis instruments and controllers or Machine Tool automation and Variable Speed Motors. Vacancies: Manchester, London & Glasgow.

MARINE RADIO & RADAR
Applicants must have P.M.G. 1st Class Certificates and M.O.T. Radar Certificate, or at least 3 years' experience on a shore Staff, or be ex-Royal Naval C.P.O. or P.O. Radio Electricians, who are welcomed. Vacancies: Manchester, London, Southampton.

Applicants must be British, live in the above towns or near, and hold a current driving licence.

Apply:
68 GROSVENOR ST., MANCHESTER 1
(061) ARDWICK 5011

SENIOR TEST ENGINEER (Industrial Electronics)

required for a new Test Department in a rapidly expanding new Company. Excellent prospects.

Apply:
Electrodynamic & Hewitt Electronics Ltd.,
Station Approach,
St. Mary Cray,
Orpington, Kent.

PRINTED CIRCUITS

One-off or medium-size runs quickly and economically. Plating and special techniques. We would be pleased to give a quotation or to send details of service.

P & M SERVICES, 126, Ramsay St., Rochdale, Lancs

14WW—160 **FOR FURTHER DETAILS.**

NEW GRAM AND SOUND EQUIPMENT

TAPE recorders and decks by Ferrograph, Brenell, Truvox, Vortexion, Telefunken. TUNERS and amplifiers by Quad, Leak, Rogers, Chapman.
MICROPHONES and stands by AKG, Reslo, STC, etc.
THE fabulous Microkit condenser mic., highest professional performance, kit 20gns; complete ready to use, 25gns.
ALL tapes and accessories.
RAPID postal service anywhere in world; good quality part exchanges welcome; h.p. facilities; specialist audio service dept., records, all labels —Parastat service.
LAMBDA RECORD Co., 95, Liverpool Rd., Liverpool, 23. Tel. Great Crosby 4012. [2868

WANTED, all types of communications receivers and test equipment.—Details to R. T. & I. Electronics, Ltd., Ashville Old Hall, Ashville Rd., London, E.11. Ley. 4986. [0163

"EROICA" Recording Studio (Est. 1949) for studio and mobile recording, tape/disc service, professional quality tape recorders (series Y and 5 Ferrograph, etc.) supplied for research, language training, etc.; one only Truvox PD 85 quarter track tape unit as new, offered at £40.
EROICA HOUSE, Ashley Rd., Altrincham. Alt. 6688. Studio Director: Wm. Thurlow-Smith, A.R.M.C.M. [0122

RETURN of post service; record changers, players and tape decks, some at special prices; speakers, Martin type kits, Mullard amplifier kits, Jason tuners, test meters, all in stock. H P available; send for free illustrated lists, postal only.—Watts Radio, Ltd., 54, Church St., Weybridge, Surrey. Tel. 47556. [0077

CHIEF OF TEST

ELECTRONICS/ELECTRO-ACOUSTICS

An experienced man required with good background electronics and/or communication equipment testing, coupled with ability to deal with administration of Test Dept. Desirable but not essential applicant should be familiar with principles of acoustical tests.

Failing experience in similar field, applicant considered who has good general background and ability rapidly to master the requirements. Salary commensurate with qualifications and experience.

Apply: Personnel Officer, Amplivox Ltd., Beresford Avenue, Wembley, Middx.
WEM 8991

You are interested in Radio and T.V.—Why not—

PUT SOME LETTERS AFTER YOUR NAME

You can rapidly qualify in your spare time by means of an absorbingly interesting Chambers Postal Course. We offer expert and highly personal training backed by a "SATISFACTION - OR - MONEY - BACK" Guarantee. Over 75 years' experience . . . thousands of successes.

FREE 100-PAGE GUIDE

Choose from hundreds of Courses — Practical Radio (apparatus supplied), Radio & T.V. Servicing, Applied Electronics, P.M.G. Cert., City & Guilds, R.T.E.B., A.M.I.E.R.E., Radio Amateurs Exam etc. Send today for the informative 100-Page *Chambers Guide To Success* — FREE. (Please state Career, exam or subject of interest).

Chambers College

(Dept. 11) 148 Holborn, London, E.C.1.

14WW—161 FOR FURTHER DETAILS.

WE purchase for spot cash, modern used hi-fi equipment, quality tape recorders, communication RXS, stereo gear, etc., etc.: call write or telephone, best prices given—Miller's Radio, 38a, Newport Court, few yards from Leicester Square Underground station. Ger. 4638. Est 20 years. Buyer can collect within 100 miles radius. [0237

REPAIRS AND SERVICE

SPEAKER repairs, cones fitted, guaranteed satisfaction.—L.S. Repair Services, Pluckley, Ashford, Kent. [0223

BOULTONS OF BRADFORD, loudspeaker and pressure unit repairs, D.C.B. cone assemblies in cartons, satisfaction guaranteed.—D. C. Boulton, 134, Thornton Rd., Bradford, 1. Tel. 22838. [0171

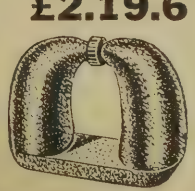
BRIMAR TUBES

BRAND NEW 45/-

TYPE C.17 A.F.

110 deg. Fantastic opportunity. Cancelled export order. Brand new television tubes in original makers' cartons at a fraction of original cost. Only 45/- each, plus post and packing 10/-. Discounts for quantity.

PERMANENT MAGNET £2.19.6



Manufactured from special COBALT ALLOY

Permanent and extremely powerful.

Indispensable in electronics, engineering, schools, etc. Offered to you at a fraction of manufacturer's price and supplied with keeper and specially made box. 60lb. lifting power, £2/19/6. P.P. 5/6.

MOBILE SALES CO. (TUL 0121)

101-3 BRIXTON HILL, LONDON, S.W.2

14WW—162 FOR FURTHER DETAILS.

G.E.C.

TELECOMMUNICATIONS

G.E.C. (Telecommunications) Ltd. manufacture a wide range of equipment from audio line repeaters to complete micro-wave transmission systems. We require the following staff:—

TEST DEPARTMENT

Vacancies exist in the Test Department for work on the above systems and associated test equipment. Men are required with some years experience of electronic equipment preferably combined with a formal qualification. Recent experience gained in the Services is valuable. Starting salaries are from £15 though some vacancies exist at a lower level.

CONTRACT ENGINEERS

These vacancies would be particularly attractive to men who have had wide experience of the installation and commissioning of telecommunications systems and who are now seeking static employment. Starting salary not less than £1,100.

ELECTRONIC DESIGN ENGINEERS

The job involves the production of manufacturing drawings from laboratory schematic sketches. A formal qualification together with a mechanical as well as an electronic bent and draughting experience are required. Starting salaries are in the bracket of £15-£18 for those with an appropriate City and Guilds final or O.N.C. and higher for those with H.N.C. or similar qualifications or experience.

SYSTEMS PLANNING ENGINEERS

We require qualified engineers who have had experience of planning large scale transmission systems preferably with overseas telephone Companies Specialised knowledge of line and/or radio systems is essential.

INSTALLATION ENGINEERS

We would like to see men with several years experience of electronic or communications equipment who are prepared to travel extensively in the U.K., the activities of the Installation Department are world-wide and opportunities for overseas travel will arise. Applications from artificers, technicians and fitters completing regular engagements with the Services are most welcome. Salaries are in the range £18-£21 a week and higher for experienced engineers.

APPLY:

With concise details to:—

The Staff Officer,

G.E.C. (TELECOMMUNICATIONS) LTD.

Coventry

SPEEDY and expert tape recorder and hi-fi repairs by England's leading hi-fi specialists. —Telesonic, Ltd., 92, Tottenham Ct. Rd., London, W.1. Mus. 8177. [0045

ARTICLES FOR SALE

A.R. 88 receiver spare valves, speaker, etc.; £40.—41, Mote Ave., Maidstone, Kent. [21

MAINS stabiliser 2.5a/230v; £20.—18, Sherwood Road, Addiscombe, Sy. (Add. 6470.) [22

RADIO LUXEMBOURG (LONDON), Ltd., have for sale 2 E.M.I. BTR1 recorders, Philips EL10030 and EL3570 recorders and an E.M.I. Mixer, all suitable for modification.—38, Hertford St., London, W.1 [1048

H.M.V. tape recorder (£56 model), unused; Marconi C.R.100 receiver with service manual, perfect order, seen London; offers around £25 for each.—Box WW 25, Wireless World. Fro. 2600 evngs.

CAPACITY AVAILABLE

INJECTION MOULDING up to 4oz. vacuum forming up to 8ft×4ft; cheap dies and short runs a speciality.—Shavelson, 2-6, Code St., London, E.1. Bis. 0225. [1017

AIRTRONICS, Ltd., for coil winding, assembly and wiring of electronic equipment, transistorised sub-units, sheet metal work.—4, Ashmead Rd., London, S.E.8. Tel. Tideway 2249 [23

SUB-ASSEMBLY, wiring, testing and inspection. Small unit service work. Layout of components, parts, etc. Delivery and collection if necessary.—Write or tel. Mersea Marine Services Co., High Street, Burnham-on-Crouch, Essex. Tel. 3335. [12

GLASGOW.—Recorders bought, sold, exchanged; cameras, etc., exchanged for recorders or vice-versa.—Victor Morris, 343, Argyle St., Glasgow, C.2. [0201

study radio or electronics a new way!

NATIONAL EXTENSION COLLEGE

A unique correspondence college offering modern technical home-study courses.

These courses, run by fully qualified tutors, make use of every modern teaching technique and offer optional residential study at week-ends. Courses include:

Elementary Radio
A correspondence course in elementary radio engineering which includes the use of home assembly kits.

Electronic Engineering (introductory)
In association with CREI—the only correspondence course recognised professionally in U.S.A. Includes home study and practical.

Send coupon for free brochure, stating course you are interested in, to:

National Extension College (ES)
Advisory Centre for Education Ltd.
57 Russell Street, Cambridge.

NAME _____

ADDRESS _____

_____

COURSE _____

TA548

YOUR CAREER IN RADIO?

Big opportunities and big money await the qualified man in every field of Electronics today—both in the U.K. and throughout the world. We offer the finest home study training for all subjects in radio, television, etc., especially for the **CITY & GUILDS EXAMS.** (Technicians' Certificates); the Grad. Brit. I.R.E. Exam.; the **Radio Amateur's Licence; P.M.G.** Certificates; the R.T.E.B. Servicing Certificates, etc. **Also** courses in Television; Transistors; Radar; Computers; Servomechanisms; Mathematics and Practical Transistor Radio course with equipment. We have **OVER 20 YEARS'** experience in teaching radio subjects and an unbroken record of exam. successes. We are the only privately run British home study Institute specialising in electronic subjects only. Fullest details will be gladly sent without any obligation.

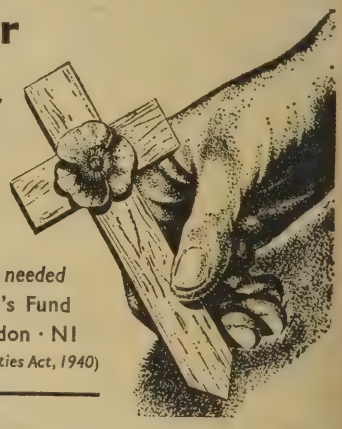
SEND FOR FREE BROCHURE TO :-

BRITISH NATIONAL RADIO SCHOOL

DEPT 1 · RADIO HOUSE · RUSSELL ST · READING · BERKSHIRE

14WW—163 FOR FURTHER DETAILS.

Remember POPPY DAY



Poppy Sellers urgently needed
British Legion · Haig's Fund
70-80 York Way · London · N1
(Registered under the War Charities Act, 1940)

EMI

ENGINEERS FOR NIGERIA

The Broadcasting Company of Northern Nigeria, an associate company of **E.M.I. Electronics Ltd.,** require Engineers with experience of medium and high-power, medium-wave, short-wave and TV transmitters for operational duties in Northern Nigeria. Experience in the maintenance of microwave link equipment an advantage.

The preferred candidates should not be more than 30 years of age and possess the qualification of H.N.C. Electrical or equivalent.

These posts offer an attractive salary together with a generous overseas allowance and home leave at the end of each 15 months' tour. Accommodation will be provided at a nominal rental of 7½% of basic salary and a company car made available.

Applications should be made in writing giving details of experience and qualifications, quoting reference No. WW/NBC/4 to:—

Group Personnel Manager, 04213/F,
E.M.I. Limited,
Blyth Road, Hayes, Middlesex

TAPE RECORDING, ETC.

"SLEEP learning," the book essential for all go-ahead people.—Send 6/6 to York House, Huddersfield. [0187

A UNIQUE Buy! Recording tape, top brand. 7in. 2,400ft D.P., 25/-; 5¾in 1,200ft, 19/6; p. & p. 1/6 per spool; bargains in all sizes; s.a.e. for list; we repair, buy and sell recorders. —E. C. Kingsley & Co., Ltd., 132, Tottenham Court Rd., London, W.1. Euston 6500. [0272

NEW TEST EQUIPMENT

MARCONI Q meter, TF 329G, in perfect order, with brand new case of inductors, £55; spare case of 18 inductors, TM 1483, £12; Marconi audio alternator TF338B brand new, £10.
AVO valve tester, type 160, brand new in crate, manual, £45; valve voltmeter, CT54, by Electronic Instruments, Ltd., new, £18.—B. L. Cedar, 2a, Convent Hill, London, S.E.19. Liv. 8489 evenings. [27

WEBB'S
FOR EXPEDITIOUS EXPORT

Eddystone "EC10" (transistorized)
Delivered U.K. £48.0.0
or posted anywhere abroad £49.10.0

Pye "SOLENT" Yachtsman's D.F. receiver (transistorized)
Delivered U.K. £51.9.0
or posted abroad £52.19.0

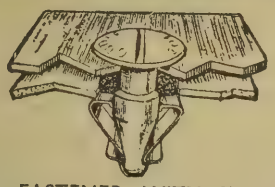
Eddystone "EA12" (Amateur bands)
Delivered U.K. £185.0.0
Quotations for overseas freight

WEBB'S RADIO

14 SOHO STREET, OXFORD STREET, LONDON, W.1 'phone GERrard 2089

14WW—164 FOR FURTHER DETAILS.

ODDIE FASTENERS



THE FASTENER WITH ENDLESS APPLICATIONS - SIMPLE - POSITIVE SELF - LOCKING. MADE IN A VARIETY OF TYPES AND SIZES. SPECIAL FASTENERS TO SUIT CUSTOMERS' REQUIREMENTS. WIDELY USED IN THE RADIO INDUSTRY

Illustrated brochure and other information will be gladly sent on request.

ROSS, COURTNEY & COMPANY, LTD.
(ODDIE FASTENERS DIVISION)
Terminal House, Elthorne Road, London, N.19. *TEL.: ARChway 0551*
CABLES: "HOMONYMS, HOLWAY," LONDON

14W W—165 FOR FURTHER DETAILS.

TEST EQUIPMENT—SURPLUS AND SECONDHAND

SIGNAL generators, oscilloscopes, output meters, wave voltmeters, frequency meters, multi-range meters, etc., etc., in stock.—R. T. & I. Electronics, Ltd., Ashville Old Hall, Ashville Rd., London, E.11. Ley. 4986. [0058

NOTICES

THE ASSOCIATION OF PROFESSIONAL RECORDING STUDIOS, Ltd., to protect and encourage the interests of member studios engaged in electrical sound recording.—Write to the General Secretary, A.P.R.S., Flat 4, 34a, Arterberry Rd., London, S.W.20. [0173

VALVES

VALVE cartons by return at keen prices; send 1/- for all samples and list.—J. & A., Boxmakers, 75a, Godwin St., Bradford, 1. [0172

VALVES WANTED

WE buy valves for cash, large or small quantities, old types or the latest; send details, quotations by return.—Waltons Wireless Stores, 15, Church St., Wolverhampton. [0102

ALL types of valves British or American, transmitting and receiving; keenest cash prices paid. What have you got to offer?—Write or call Lowe Bros., 95-97, Redchurch St., London, E.2. Tel. Shoreditch 4415-6. [2882

DALY

Electrolytic Capacitors

* Electronic Flash
* Energy Storage
* Motor Starters

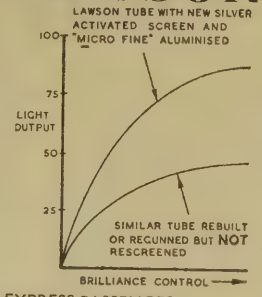
DALY (Condensers) **LTD**
Ealing Green · Ealing · London · W5
EAL 3127 · Cables: Dalycon · London

DALY

14W W—167 FOR FURTHER DETAILS.

LAWSON

LAWSON TUBE WITH NEW SILVER ACTIVATED SCREEN AND "MICRO FINE" ALUMINISED



EXPRESS PASSENGER TRAIN SERVICE
Our service is country wide and whether you live in the Outer Hebrides or at No. 10 we can guarantee the finest and fastest CRT service in Great Britain.

Full fitting instructions with every tube.

LAWSON TUBES
2, PEACHFIELD CLOSE, MALVERN WELLS, WORCS.
TEL.: 2100

DIRECT REPLACEMENT TELEVISION TUBES

12 MONTHS *FULL REPLACEMENT* GUARANTEE

DESIGNED FOR PERFORMANCE

The modern Lawson Television tubes are specially designed to give the older types of television set very much improved performance. Their new silver activated screens are much brighter with better contrast, exclusive "micro fine" controlled thickness aluminising gives 50 per cent. more light output. New small anode aperture electron guns by Mullard, Mazda, G.E.C., Brimar, E.E., Cossor, etc., give crisp needle-sharp definition and focus. Silicon vacuum pumping plus depth formed cathodes giving very long life. Each tube is 100 per cent. **BRAND NEW** (glass excepted) and is designed to fit exactly as the original tube, ensuring complete accuracy and efficiency.

FROM STOCKS OF OVER 5,000 TUBES OF EVERY MAKE AND TYPE, WE CAN SUPPLY THE *EXACT* TUBE YOU REQUIRE BY RETURN.

12"—£4:10:0
14"—£5:10:0
15"-17"—£5:19:0
19"-21"—£7:19:0
CARR. & INS. 7/6

Terms **C.O.D. or C.W.O**

10/- Gladly refunded if you wish to return your old tube (excluding 12in.).

14W W—166 FOR FURTHER DETAILS.

MINISTRY OF DEFENCE (Air Force Department) requires Examiners (Technical Class Grade III) in the Radio Division of the Aeronautical Inspection Service.

DUTIES. At Henlow the calibration of a wide range of electronic equipment and the compilation of calibration manuals. At other units, the technical supervision of staff, the inspection and testing of equipment and submission of inspection schedules.

LOCATION. Vacancies exist mainly at Henlow, Western and Northern England, S. Wales and N. Ireland.

QUALIFICATIONS. Applicants must be British subjects. A full five year apprenticeship or equivalent training. Experience in the development, manufacture, inspection, maintenance or testing of wireless or radar equipment. O.N.C. (Elect.) or City & Guilds Intermediate Certificate plus Radio II or an equivalent qualification. Applicants must be prepared to serve a tour or tours of 2 or 3 years duration overseas.

APPOINTMENTS will be unestablished. Establishment is by open competitions, which are held periodically.

SALARY. National Scale £798—£1,091. Age 28 and over start at £975. Prospects of promotion to higher grades with a maximum of £1,767. Applications and further details from Ministry of Defence C.E.3f(Air). Sentinel House, Southampton Row, W.C.1

• DEVELOPMENT ENGINEERS

required for experimental work on receiving equipment in the VHF and UHF bands. Experience of semi-conductors essential.
Excellent conditions of employment. Generous pension and holiday arrangements. Our premises are situated in a pleasant part of Dorset within easy reach of Bournemouth.

Applications with full details of experience and qualifications to:—

The Personnel Manager,
FLIGHT REFUELLING LIMITED,
Wimborne, Dorset.

THE HIGH-FIDELITY MAIL ORDER SPECIALISTS

GOODS DESPATCHED BY RETURN

Carriage, Packing & Insurance (U.K.) FREE!!

AMPLIFIERS . TUNERS . SPEAKERS . MOTORS . PICKUPS . MICROPHONES
CABINETS . TAPE RECORDERS

ACOS A.D.C., ARMSTRONG, B and O, BRENELL, CELESTION, CHAPMAN, CONNOISSEUR, DECCA, DULCI, FERROGRAPH, FI-CORD GARRARD, GOODMANS, JASON, K.E.F., LEAK, LOWTHER, LENCO, LUSTRAPHONE, PHILIPS, PYE, QUAD, RADFORD, RECORD HOUSING, ROGERS, RONETTE, S.M.E., TANNOY, THORENS, TRUVOX, T.S.L., VORTEXION, W.B., WEARITE, WHARFEDALE, ETC.

Hire Purchase terms available ● *"Comparator" Demonstrations*

WORLD WIDE EXPORTERS

★ *OVERSEAS ORDERS SENT FREE OF PURCHASE TAX AND SHIPPED PROMPTLY AT MINIMUM COST* ★

C. C. GOODWIN (SALES) LTD.

(Dept. W58) 7 THE BROADWAY, WOOD GREEN
LONDON, N.22. *Open 9-6 Thurs. 1 p.m.* Tel: BOWes Park 0077/8

OVER 2,000 COMBINATIONS "LAB-AIDS" TEST LEADS.

AVONCEL

Heavy duty P.V.C. cables - eleven distinguishing colours.
Solderless crimped terminals.
Nickel-plated crocodile clips with axial riveted jaws.
Lead lengths 3, 6, 12, 18, 24 and 36 inches.
Alternative clips, plugs and spades.
Individually tested and sealed in plastic bags.
Comprehensive kits - include support racks.
Special leads produced to order.

"LAB-AIDS" DIVISION,
AVON COMMUNICATIONS & ELECTRONICS LIMITED,
14-16a, HIGH ST., CHRISTCHURCH : 2469 · HAMPSHIRE

14WW—168 FOR FURTHER DETAILS.

COILS, CHASSIS, CASES, ETC.

Precision Wound Supersensitive Coils—JDR1 Dual-Range **Ferrite Rod Aerial**, 8 x ⅜in. with circuits, **10/-**; JDR2 **Matched Pair Dual-Range Coils** with reaction and circuits, **7/6**; JDRX1 **Miniature Dual-Range Coil** with reaction and circuits, **3/6**; **Printed Circuit Kit** comprising 6 x 3in. printed circuit (of 3 transistor Reflex Radio), Ferrite Rod, All Coils with plans, **18/6**, suitable Cabinet, **7/6**; **Radio or Instrument Case**, crackle finished, 8 x 5 x 4in. with handles and front panel, **18/6**. Add 1/- P. & P., over 10/- add 2/-.

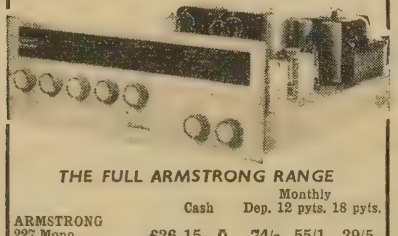
Production Undertaken of Coils, Chassis, Metal Cases, lowest prices consistent with quality. TRADE ENQUIRIES INVITED.

JETRONIC ENGINEERING CO. LTD.
(Dept. WW1), 9 **Western Road, Hove.**
(*Catalogue of Coil Range, Metal Work, etc.* 1/-)

14WW—169 FOR FURTHER DETAILS.

SPECIAL OFFERS

NO INTEREST ON 12 MONTHLY PAYMENTS



THE FULL ARMSTRONG RANGE

	Cash	Monthly Dep.	12 pyts.	18 pyts.
ARMSTRONG				
227 Mono	£36 15 0	74/-	55/1	39/5
227 Stereo	£52 15 0	106/-	79/1	56/9
223 AM/FM Tuner	£28 15 0	57/-	43/2	30/10
224 FM Tuner	£22 10 0	45/-	33/9	24/3
222 Amp.	£27 10 0	55/-	41/3	29/7
220/225 Amp. and Pre-amp.	£47 10 0	95/-	71/3	51/1
GARRARD				
AT6/EV26A	£13 5 2	26/2	19/11	14/4
3000 LM 90	£11 11 11	23/11	17/4	12/6
4HF/EV26A	£12 15 2	25/2	19/2	13/9
301 Strobe	£18 1 4	36/4	27/1	19/5
LEAK				
Stereo 30	£49 10 0	99/-	74/3	53/3
Stereo 20/Vari II	£57 10 0	115/-	86/3	61/9
TL 12/Vari	£35 15 0	72/-	53/7	38/5
Troubline 3	£31 14 6	63/6	47/7	34/1
Sandwich	£39 18 0	80/-	59/10	43/-
LENCO				
GL58	£17 1 9	35/9	25/6	18/4
GL70	£27 9 4	55/4	41/2	29/6
GL88	£18 18 5	38/5	28/4	20/4
MISCELLANEOUS				
Goodmans Maxim	£17 10 6	35/6	26/3	18/10
Goodmans Eleganzia II	£27 10 0	55/-	41/3	29/7
Kef Celeste	£24 19 0	50/-	37/5	26/10
Jordan Watts A12	£22 0 0	44/-	33/-	23 8
Cadet Stereo	£26 15 0	54/-	40/1	28/10
Decca Deram AR1	£11 11 0	23/-	17/4	12/6

Showroom hours: Monday-Saturday 10 a.m.-5 p.m.
Directions: No. 6 bus from Liverpool St. Station to Odeon, Hackney Rd., walk back two turnings.

A. L. STAMFORD Ltd (DEPT. H4) Phone: SHO 5003
98 Weymouth Terrace, London, E.2.

FANS

We manufacture a small efficient electric fan primarily intended for Extraction and/or circulation of air in Electronic Equipment. Our Fan is mounted on a bracket which may be removed if not required.

Abridged Specification

Fan Blade O/D. .6in., Rating..10 watts, Voltage at 50 c/s. . .200/250 v., Rotation. .2,800 R.P.M.
Air displacement exceeds 100 sq. ft./min.
Price **29/-** ea. Carriage paid.

KENURE, HOLT & CO. LTD.,
BOYN VALLEY ROAD, MAIDENHEAD, BERKS.
Tel.: 25225. Quote ref.: AWA/W.WD.

14WW—170 FOR FURTHER DETAILS.

WANTED, EXCHANGES

A PROMPT cash offer for your surplus brand-new valves and transistors.—R.H.S., Beverley House, Manville Terrace, Bradford, 7. [0191

URGENTLY wanted, manuals or instruction books, data, etc., on American or British Army, Navy or Air Force radio and electrical equipment.—Harris, 93, Wardour St., W.1. Gerrard 2504. [2824

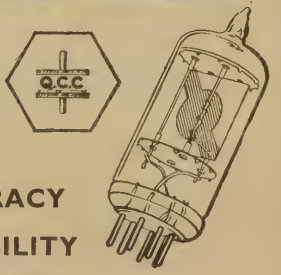
WAYNE Kerr component bridge B221, possibly B521; buy or exchange for 1.2 mc/s, 7 digit counter/timer, or digital voltmeter, 4 digit, a.c. or d.c., automatic range selection to 999.9 volts; or oscilloscope, several types available.—Branson, 111, Park Rd., Peterborough. [28

SERVICES OFFERED

PRINTED circuit service; small quantity runs quickly and economical.—Quotations and information from Teleradio Co., Ltd., 18, Turnpike Lane, N 8 [2888

CATHODE ray tubes, direct from factory offer, your tube rebuilt to brand new with latest type superior American gun, quick service with full year guarantee, example: 17in, £4/7/6.—Write for full details now to Electronic Services, Ltd., 44, Pulman St., Hull. [26

Quartz Crystal Units



For

ACCURACY
RELIABILITY
PRICE ECONOMY

you can DEPEND on

Write for illustrated Brochure & Price List.

THE QUARTZ CRYSTAL CO. LTD.
Q.C.C. Works, Wellington Crescent
New Malden, Surrey (*MALden 0334 & 2988*)

14WW—171 FOR FURTHER DETAILS.

ALL makes and types of communications receivers, transmitters overhauled to original specifications, AR88D-LF, etc., trade facilities available, your home and export enquiries invited.—Dept. "P," Highgate Radio Services, 219, Moseley Rd., Birmingham, 12. Cal. 1039. [1049

AGENCIES, ETC.

WE undertake the manufacture of transformers singly or in quantities to any specification all work guaranteed for 12 months.
LADBROKE TRANSFORMER Co., Ltd., 820a, Harrow Rd., London, N.W.10. Tel. Ladbroke 0914. [0220

TECHNICAL TRAINING

LEARN Radio and Electronics the New Practical Way! Very latest system of experimenting with and building radio apparatus—"as you learn."—Free brochure from Dept. W.W.10, Radiostructor, Reading. [0241

RADIO and TV exams. and courses by Britain's finest home study school; coaching for I.E.R.E., City & Guilds, Amateurs Licence, R.T.E.B., P.M.G. Cert., etc.; free brochure from—British National Radio School, Russell St., Reading. [0189

RELAYS

LARGE STOCKS ★ KEEN PRICES ★ QUICK DELIVERIES

FROM STOCK OR BUILT TO SPECIFICATION. COIL VALUES—UP TO 22,000 OHMS SINGLE — TWIN — SLUGGED
BUILD UPS — MAKES, BREAKS, C/O's ETC-SILVER — PLATINUM — HEAVY DUTY
COMPONENT PARTS SOLD SEPARATELY.
Write us your requirements

P.O. TYPES 3000 & 600
G.E.C.
SIEMENS
S.T.C.
SEALED & HIGH SPEED

SPECIAL OFFER—TO CLEAR—3,000 TYPE ONLY
Complete tested relays—ex Unit—Immediate delivery.
Coil values up to 6,500 ohms.
1 C/O ... 7/6 2 C/O 9/-
4 C/O ... 10/5 6 C/O 12/6
Postage 1/6.
Also many other combinations of contacts.
N.B. Special Prices for over 100 lots.
Over 10,000 type 3,000 coils to clear at special prices.

STOCKS STILL AVAILABLE OF ROTARY TRANSFORMERS AND DYNAMOTORS from 30/-, p.p. 5/-. **SLIDING RESISTANCES** 0.4 ohms., 250 watts to carry 25 amps., worm drive, 1 ohm, 125 watts to carry 12 amps., slider type (12/6 each, 5/- post). **LOUD HAILER DIAPHRAGMS** (5/- each, 1/- post). **BELLING FUSEHOLDERS**, ex unit, one hole fixing (1/- each, 6d. post). **RECTIFIERS**, ex unit, G.E.C., 12 volt, 1 amp., 5 plates (4/6 each, 1/- post). **KEYSWITCHES**, various, ex unit (2/6 each, 1/- post). MANY OTHER LOW PRICED LINES FOR CALLERS

DEPENDABLE RADIO SUPPLIES LTD.
12A Tottenham Street, London, W.1.
Telephone: LAN 7391/2
WRITE—CALL—PHONE

LONDON CENTRAL RADIO STORES

EX EQUIPMENT: COLLARO. 3 speed auto changers complete with arm and p.u. Hi-Fidelity Model RC54 also Model RC531 A.C. mains. Approx. size 13in. × 11½in. Height 7in. **£3. P. & P. 10/-.**

INTER-COM TELEPHONES

20-WAY PRESS-BUTTON INTER-COM TELEPHONES in Bakelite case with junction box. Thoroughly overhauled. Guaranteed. **£7/15/-.** Per Unit. Complete Installation **£135.**

10-WAY PRESS-BUTTON INTER-COM TELEPHONES in Bakelite case with junction box. Thoroughly overhauled. Guaranteed. **£6/15/-.** Per Unit. Complete Installation **£60.** Wiring Diagrams for 10 and 20 ways on application.

P.M. MOVING COIL SPEAKERS
5in. **9/6.** 8in. 3 ohm **10/6.** Elliptical 7×4in. 3 ohm **10/6**

SUPERIOR TYPE DESK PHONES, black Bakelite cases. Complete with Hand Set. Dial 0-9 and internal bell. **£3/7/6.**

G.P.O. TELEPHONE TYPE CARBON HANDSETS 10/6.

PARMEKO CHOKES 5H 180 MA. Size approx. 2¼"×1" **6/-.**

ELECTRICITY SLOT METERS (1/- in slot) for A.C. mains. Fixed tariff to your requirements. Suitable for hotels, etc. 200/250 v. 10 A. **84/-**; 15 A. **94/-**; 20 A. **104/-**; other amperages available. Reconditioned as new. 2 years' guarantee.

QUARTERLY ELECTRIC CHECK METERS. Reconditioned as new. 200/250 v. 10 A. **42/6**; 15 A. **52/6**; 20 A. **57/6.** Other amperages available. 2 years' guarantee.

BRASS JACK STRIPS. 10 Jack sockets in each strip. Size approx. 11×3½in. **12/6.**

8-BANK UNISELECTOR SWITCHES. 25 contacts, alternate wiping **£2/15/-.** 8 bank half wipe **£2/15/-.** 6 banks, half wipe, 25 contacts. **47/6.**

ALL GAUGES INSTRUMENT WIRE. Tin copper enamelled cotton silk resistance wires from 16 S.W.G. to 50 S.W.G. List sent on request. Send S.A.E.

HIGH-SPEED ELECTRO-MAGNETIC COUNTERS. Ex-Govt. 0-9,999, 25/50v. D.C. Size 4×1×1in. Single coil 2,300Ω. Single coil 500Ω **15/-.**

MOVING COIL HEADPHONES with chamois wash leather earpads, **25/-.**

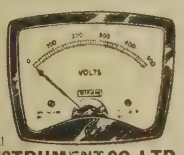
CHROME TELEPHONE DIALS. 0-9. Suitable for inter-office and factory installation. **12/6.**

All prices include carriage in United Kingdom "Except where otherwise stated"

23 LISLE ST. (GER. 2969) LONDON, W.C.2

Closed Thursday 1 p.m. Open all day Saturday

Instrumentation at its best . . .



SIFAM ELECTRICAL INSTRUMENT CO. LTD.
WOODLAND ROAD, TORQUAY Tel: 3822/3

14WW—172 FOR FURTHER DETAILS.

The RADIO AMATEURS HANDBOOK 36/-

1964 ED. by A.R.R.L. Postage 2/6.

Transistor Ignition Systems Handbook by Ward. Postage 1/- **20/-**

101 Ways to Use Your Signal Generator by Middleton. Postage 1/- ... **18/-**

Introduction to Lasers and Masers by Lytel. Postage 1/-. **16/-**

A.B.C.'s of Computers by Lytel. Postage 1/- **16/-**

Television and Radio Line Distribution, by Penrose. Postage 2/- **30/-**

Electronic Organ for the Home Constructor, new ed., by Douglas. Postage 1/- **20/-**

Beginners Guide to Electronics, by Squires. Postage 1/- **15/-**

Teach Yourself Radio Servicing, by Butterworth. Postage 1/- **10/6**

Guide to Broadcasting Stations, new ed., by W.W. Postage 6d. **5/-**

UNIVERSAL BOOK CO.
12 LITTLE NEWPORT STREET
LONDON, W.C.2.
(adjoining Lisle Street).

Record Cleaning & Maintenance Equipment

Send stamps value 9d. for post free copy of 16 page booklet "A Guide to the better care of your L.P. and Stereo Records."

CECIL E. WATTS LTD.

Consultant & Sound Engineer

Darby House Sunbury-on-Thames, Middx
14WW—173 FOR FURTHER DETAILS.

TEACHING IN TECHNICAL COLLEGES.

APPLICATIONS are invited from graduates and from suitably qualified persons between 25 and about 45 to train to become teachers in mathematics, engineering, physics, chemistry, metallurgy, food and catering, commerce and business studies, typewriting and shorthand, architecture and building, hairdressing, management studies, agriculture, printing, mining and natural sciences.
TUITION is free, personal and dependants' maintenance allowances are granted, and travelling expenses are paid.
CANDIDATES should have good industrial or commercial experience and hold the Full Technological Certificate, Higher National Diploma or Certificate or equivalent qualification.
INQUIRIES quoting **Ref. S27,** to one of the following:—
DIRECTOR, Bolton Training College, Chadwick Street, Bolton.
DIRECTOR, Huddersfield Training College, Holly Bank Road, Lindley, Huddersfield.
PRINCIPAL, Garnett College, Downshire House, Roehampton Lane, London, S.W.15.
PRINCIPAL, Wolverhampton Technical Teachers' College, Compton Road West, Wolverhampton. [1045

CITY & GUILDS (electrical, etc.), on "No Pass—No Fee" terms, over 95% successes.—For details of modern courses in all branches of electrical engineering, applied electronics, automation, etc., send for 148-page Handbook—free and post free.—B.I.E.T. (Dept. 388A), 29, Wright's Lane, London, W.8. [0017

P.M.G. Certificates. City & Guilds Examinations, I.E.R.E., also many non-examination courses in radio, TV and electronics; study at home with world famous I.C.S.—Write for free prospectus, stating subject, to International Correspondence Schools (Dept. 443), Intertext House, Parkgate Rd., London, S.W.11. [0029

MISCELLANEOUS

AUSTRALIA.
ARE YOU THINKING OF IMMIGRATING? THIS is a lifetime decision.. English Professional Engineers have formed an ADVICE BUREAU to assist prospective migrants in Electronics, Radio, T.V. & Electrical Fields to acquire up to date information on all aspects of this country.—For details of services write to K.E. Advice Bureau, P.O. Box 126, ASHFIELD, N.S.W. [10

SEEN my cat? Electrical, relays, mechanical, materials, tools; s.a.e.—Whiston (Dept. WCW), New Mills, Stockport. [2729

RADIO remote control, 25/30mc/s systems, transmitters, receivers and servos, designs and complete equipment available.—Teleradio Electronics, 18, Turnpike Lane, N.8. [2929

BENSON'S better bargains, send s.a.e. for free catalogue of Government and manufacturers' electronic surplus. to—Superadio (W.), Ltd., 116, Whitechapel, Liverpool, 1. [100

CATALOGUE No. 15, government surplus electrical and radio equipment, hundreds of items at bargain prices for the experimenter and research engineer; 2/6 post free, catalogue cost refunded on purchase of 50/-.—Arthur Sallis Radio Control, Ltd., 93, North Rd., Brighton. [0195

Audix
SOUND SYSTEMS
AUDIO EQUIPMENT MANUFACTURES
STANSTED, ESSEX.
Phone: STANSTED 3132

14WW—174 FOR FURTHER DETAILS.

EXCLUSIVE OFFERS

AMERICAN AVIONIC EQUIPMENT

★ **AN/GRC-32** 225/399 Mc/s transmitters, receivers, modulators, power units, antennae.
★ **AN/GRC-27** 225/399 Mc/s. transmitters, receivers, modulators, power units, antennae.
★ **AN/FPN-13** Radar.
★ **AN/ARC-33 MD-141A/GR** modulators.
★ **BOEING** Ground pressure refuelling Controls.
★ **AN/ARC-27** Transmitter-Receivers and Control units.

AMERICAN MICROWAVE TEST EQUIPMENT

★ **AN/UPM-33 (TS-148/UP)** Radar general purpose Test Sets 8,470/9,360 Mc/s. **AN(USM-24A**
★ **WATERMAN S5B** portable general purpose 3in. Oscilloscopes.
★ **WESTERN ELECTRIC** Teleprinter bias and Distortion Measuring Sets.
★ **R.C.A. 2/4 Mc/s. 150 w. Dummy loads. DA-72/U.**
★ **POLARAD** portable Signal Generators (fitted video signal), 2,150/4,600 Mc/s. **AN/URM-34.**
★ **HOLTZER CABOT** general purpose 500 v. Megohmeters. **AN/USM-2A.**
★ **WESTERN ELECTRIC** Relay Test equipments. I-81, I-191, I-193.
★ **BERKELEY CORPORATION** Model 554 high speed electronic Counters (digital display). **FR-67/U.**
★ **TS-352/U** Multimeter Test Sets. **(ME-9B).**
★ **TS-282e** Audio Oscillators 20/200,000 cyc.
★ **T-281/ARC-21** Test Sets.
★ **AN/PDR-39** Radiaes.
★ **AN/UPM-11** Range Calibrators (TS-738A).
★ **AN/URM-36** Signal Generators 7850/10750 mc/s.

40-page List of over 1,000 items in stock available —keep one by you.

★ **POLARAD** TS Signal Generators, 7,850/10,750 Mc/s.
★ **MUNSTON** 268D Crystal Rectifier Test Sets.
★ **TS-147D/U** aircraft Beacon Test Sets, measure frequency spectrum and fluctuation. 8,470/9,360 Mc/s.
★ **HICKOK TV-7/U** Mutual Conductance Valve Testers.
★ **PRESS WIRELESS** portable Voltage Dividers (minimum 5 kc/s, maximum 35 kV. 20 mmfd.).
★ **SPERRY T101013** Gyro Drift Turntables.
★ **SPERRY T101002** Amplifier Analyser Test Equipments.
★ **LAVOIE 239A** High Speed Oscilloscopes. **AN/USM-50.**
★ **TS-1350/TMQ** Humidity Testers.
★ **MD-33A/ARN** V.O.R. modulators.
★ **TS-H19/U** Hewlett Packard model 200 oscillators.
★ **TS-497B/URR** Signal Generators 2/400 m/cs.
★ **TS-505D/U** V.T.V.M. Multimeters.
★ **AN/ARM-7** R.F. Wattmeters.
★ **AN/URM-64** Sig. Generators 900/2,000 m/cs.
★ **TS-297/U** Multimeters.
★ **AN/UPM-6B** Radar Test Equipments.
★ **863A** Airport control tower Monitors.
★ **447G** Airport control tower Amplifying equipment.

AMERICAN TELETYPE EQUIPMENT

★ **TT-5/FG** page printers.
★ **TT-16/FG** reperforators.
★ **TD-30** tape leaders.
★ Teletype Coder-Decoder Privacy Equipments.

Carriage extra on all above.

We have a large quantity of "bits and pieces" we cannot list—please send us your requirements as we can probably help—all enquiries answered.

P. HARRIS
ORGANFORD - DORSET
WESTBOURNE 65051

14WW—175 FOR FURTHER DETAILS.

AERIAL MATCHING TUNING UNITS

LATEST AMERICAN RELEASE BULK PURCHASE OF 3,000
These well-made tuning units made for the American 19TX-RX are housed in a metal case size 4in. x 4in. x 10in., using a large precision calibrated scale, are an essential piece of equipment for the serious T.X. or R.X. operator. This unit will match an untuned wire or whip aerial to almost any short wave receiver or transmitter, exceptionally good for mobile top band use. This American version being well rated as far superior to any other. GUARANTEED BRAND NEW, only 20/-, post 7/6. Instructions supplied.

PYE OR INVICTA LOUDSPEAKER UNITS

Enclosed in a brown wooden cabinet and carrying handle, using a silver speaker mesh. Complete with 40ft. of lead and jack plug. A 10in. heavy duty 3 ohm speaker is used, being very useful for groups, halls, P.A. work, etc. (made for Army Entertainment use). BRAND NEW AND BOXED ONLY £2/15/-, carr. 5/-. A fraction of cost.

88 TX-RX POWER UNIT, 12 v. input to 90 v., 7.5 v., 1.4 volts stabilised output. Also contains L.F. Amplifier. These are sold BRAND NEW with 4 B7G valves. Only 50/-, P.P. 5/-.

J. T. SUPPLY, 38 MEADOW LANE, LEEDS 11

14WW—176 FOR FURTHER DETAILS.

DO YOU STILL USE A HAMMER AND CHISEL TO CUT A SQUARE IN SHEET METAL?

Don't any more

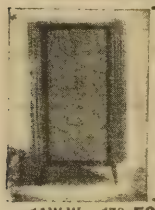
We have a Hand-operated Tool now to cut any straight sided shape. Square R/Angles slots for Louvres. All you do is simply mark out your shape and follow the lines. You can also convert the Tool to a Punch-Louvre Forming and Riveting Tool.

NO DISTORTION OF METAL ON EITHER SIDE OF CUT

EXPORT ORDERS DESPATCHED IMMEDIATELY

AVONLEA TOOLS, WOODEND MILL, MOSSLEY, LANCASHIRE.
MOSSLEY 2687

14WW—177 FOR FURTHER DETAILS.



A.D *LOUDSPEAKER ENCLOSURES*
Corner 172 ARU Enclosure for Goodmans 12" Speakers £16-10-0
A. DAVIES & CO.
(CABINET MAKERS)
3 Parkhill Place (off Parkhill Road), London, N.W.3
GULliver 5775

14WW—178 FOR FURTHER DETAILS.

"WIRELESS WORLD" TEST INSTRUMENTS

Complete sets of Metalwork, machine engraved Front Panels, Special Tag Boards and all specified 1st grade components.
For professional appearance and performance.
Send 6d. in stamps for lists.
MALVYN ENGINEERING WORKS
Engineers to the Radio and Electronic Industries
7 CURRIE STREET, HERTFORD, HERTS.
TELEPHONE: HERTFORD 2264

14WW—179 FOR FURTHER DETAILS.

CABINETS • CASES
CHASSIS
Anything in metal. "ONE OFFS" a pleasure.
Send your drawings for quote
Stove enamelled in any professional finish
MOSS, WATSON
40 MOUNT PLEASANT STREET, OLDHAM, LANCS. *MAIN 9400*

14WW—180 FOR FURTHER DETAILS.

NYLON • P.T.F.E.
ROD, BAR, SHEET, TUBE, STRIP, WIRE
No quantity too small. List on application.
BRASS . COPPER . BRONZE
ALUMINIUM . LIGHT ALLOYS
STAINLESS STEEL
H. ROLLET & Co. Ltd.
Howie Street, S.W.11. BATtersea 7872
ALSO AT LIVERPOOL, BIRMINGHAM, MANCHESTER, LEEDS, GLASGOW

14WW—181 FOR FURTHER DETAILS.

MEASURE HIGH VOLTAGES with EASE, ACCURACY and SAFETY with the Pocket Size **KILOVOLTER** • 3 to 30 kV

Ideal for checking TV, Radar, Car Ignition, etc. *Only* **97/6d.** *Trade discount 15%. Or ask for leaflet.* **WAVEFORMS LTD.** 72 Vauxhall Bridge Road, London, S.W.1. *Phone: VICtoria 3404-9*

14WW—182 FOR FURTHER DETAILS.

TANNOY

For sound sense

WEST NORWOOD LONDON SE27
GIPSY HILL 1131

14WW—183 FOR FURTHER DETAILS.

METALWORK, all types cabinets, chassis, racks, etc., to your own specification, capacity available for small milling and capstan work up to 1in bar. PHILPOTT'S METAL WORKS, Ltd., Chapman St., Loughborough. [0208

TUITION

I.E.R.E., City & Guilds and R.T.E.B. exams: specialised I.C.S. home-study course will ensure success.—For details of wide range of exam. and diploma courses in radio, T.V. and electronics, also new practical courses with kits, write to I.C.S. (Dept. 522), Parkgate Rd., London, S.W.11. [0036

STUDY radio, television and electronics with the world's largest home study organisation, I.E.R.E., City & Guilds, R.T.E.B., etc.; also practical courses with equipment; all books supplied.—Write for free prospectus, stating subject, to I.C.S. (Dept. 442), Intertext House, Parkgate Rd., London, S.W.11. [0032

BECOME "Technically Qualified" in your spare time, guaranteed diploma and exam. home-study courses in radio, TV, servicing and maintenance, R.T.E.B., City and Guilds, etc.; highly informative 120-page Guide—free! —Chambers College (Dept. 433), 148, Holborn, London, E.C.1. [0013

A.M.I.MECH.E., A.M.I.E.R.E., City & Guilds, G.C.E., etc., bring high pay and security. "No Pass—No Fee" terms. Over 95% successes. For details of Exams and courses in all branches of Engineering, Building, Electronics, etc., write for 148-page handbook—Free. B.I.E.T. (Dept. 387B), London, W.8. [0118

T.V. and Radio—A.M.I.E.R.E., City & Guilds, R.T.E.B. Cert., etc., on "No Pass—No Fee" terms, over 95% successes.—For details of exams and home training courses (including practical apparatus) in all branches of radio, T.V. and electronics, write for 148-page handbook—free. B.I.E.T. (Dept. 387A), 29, Wright's Lane, London, W.8. [0016

E. R. NICHOLLS
EX GOVERNMENT SURPLUS MAIL ORDER & RETAIL SHOP
46 LOWFIELD ROAD
STOCKPORT CHESHIRE

SEND FOR FREE LIST OF SURPLUS BARGAINS
Transformers, Chokes, Break Down Units, Switches Toggle, Rotary, Key Types, Headphones, Morse Keys. 19in Racks, Jones and Plessey Plugs and Sockets. Speakers, Min Panel Lamps, Multi-way Cable. High Stabs, ¼ watt to 5 watt. Small Instrument Cases. Copper Laminate Board Coax Plugs Sockets. Power Packs, Selsyns, Inductance Coils. Potentiometers, Printed Circuit Types to Precision Types. Valves, Tubes, Signal Generators.
ALSO SPECIAL MAILING LIST OF CLEARANCE BARGAINS.

14WW—184 FOR FURTHER DETAILS.

TESTED TRANSISTORS
OA202, 1/- each. OC44, OC45, OC81, OC81D, 3/- each. AF114/5/7, SX658, OC170/1, 4/- each. 2S013, OC26/28/35, GET571, 10/- each. XA101/2, XB103/4, XA111/2, 2/- each. RED OR WHITE SPOTS, 1/- each. OC139, BY100, GET8, 5/- each. ZENERS ¼ watt, 3/6 each. 1.5 watt, 5/- each. 7 watt, 6/- each.
S.A.E. LIST AND COMP. EQ. CHART FREE.
B. W. CURSONS
78 BROAD STREET, CANTERBURY

14WW—185 FOR FURTHER DETAILS.

SOUTHERN RADIO SUPPLY LTD.
11, LITTLE NEWPORT STREET, LONDON, W.C.2. *GERrard 6653*
GOODS AS PREVIOUSLY ADVERTISED STILL AVAILABLE
Bombsight Computers; Frequency Crystals; Test Meters No. 1; Accessories for Type "38" and "18" Transreceivers, etc., etc.

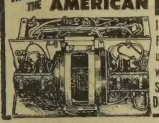
DAMAGED METER?
Have it repaired by Glaser
Reduce overheads by having your damaged Electrical Measuring Instruments repaired by L. Glaser & Co. Ltd.
INSTRUMENT REPAIRS
We specialise in the repair of all types and makes of Voltmeters, Ammeters, Microammeters, Multirange Test Meters, Electrical Thermometers, Recording Instruments, etc.
As contractors to various Government Departments, we are the leading Electrical Instrument Repairers in the Industry. For prompt estimate and speedy delivery send defective instrument by registered post, or write to Dept. W.W.:—
L. GLASER & CO. LTD.
96-100, Aldersgate Street, London. E.C.1.
Tel.: Monarch 6822

14WW—186 FOR FURTHER DETAILS.

TRANSFORMERS
COILS *LARGE OR SMALL QUANTITIES*
CHOKES *TRADE ENQUIRIES WELCOMED*
SPECIALISTS IN
FINE WIRE WINDINGS
MINIATURE TRANSFORMERS
RELAY AND INSTRUMENT COILS, ETC.
VACUUM IMPREGNATION TO APPROVED STANDARDS
ELECTRO-WINDS LTD.
CONTRACTORS TO G.P.O., A.W.R.E. L.E.B., B.B.C., ETC.
123-5-7 PARCHMORE ROAD, THORNTON HEATH, SURREY
LIVINGSTONE 2261 EST. 1933
14WW—187 FOR FURTHER DETAILS.

DELAY CABLE, *CALIBRATION AND TERMINATION SERVICE*

Using Hackethal FLEXIBLE Delax Cable
AEON
AEON Laboratories, Beech Hill, Ridgemead Road, Englefield Green, Egham, Surrey. Egham 3961/4
14WW—188 FOR FURTHER DETAILS.

240 volt ELECTRIC POWER ANYWHERE
ANYTIME! from 12 volt CAR BATTERY
WITH THE **AMERICAN DYNAMOTOR UNIT**

Input 12v. output 200/250v. at 150 to 220 watts. Perfect for TELEVISION, POWER TOOLS and all universal AC/DC ELECTRICAL EQUIPMENT, gives wonderful results. Price ONLY £8 + 12/- carriage. Send stamped envelope for full illustrated details Dept.D SCIENTIFIC PRODUCTS, CLEVELEYS, Lancs.
14WW—189 FOR FURTHER DETAILS.

THE FERRITE-WINDING WIZARDS!
NEWPORT INSTRUMENTS (Scientific & Mobile) LTD
Newport Pagnell, Bucks. Tel: 401/2

14WW—191 FOR FURTHER DETAILS.

RESISTANCE WIRES
EUREKA-CONSTANTAN
Most Gauges Available
NICKEL-CHROME MANGANIN
NICKEL-SILVER
COPPER WIRE
ENAMELLED, TINNED, LITZ, COTTON AND SILK COVERED
SMALL ORDERS PROMPLY DESPATCHED
B.A. SCREWS, NUTS, WASHERS
soldering tags, eyelets, and rivets
EBONITE and BAKELITE PANELS.
TUFNOL ROD, PAXOLIN TYPE COIL FORMERS AND TUBES, ALL DIAMETERS.
SEND STAMP FOR LIST. TRADE SUPPLIED.
POST RADIO SUPPLIES
33 Bourne Gardens, London, E.4
Phone: Clissold 4688
14WW—190 FOR FURTHER DETAILS.

FULL-TIME courses for P.M.G. certificates and the radar maintenance certificate, also in electrical and electronic engineering.—Information from College of Technology, Kingston upon Hull. [0114

RADIO officers, see the world: sea-going and shore appointments; our many recent successes provide additional trainee vacancies during 1964/1965; day and boarding students; grants and scholarships available; stamp for prospectus.—Wireless College, Colwyn Bay. [0031

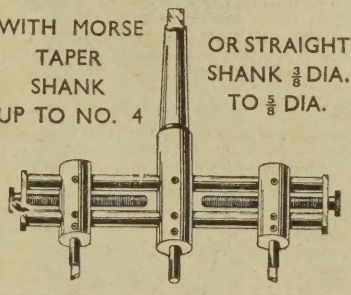
"HOW and Why" of Radio and Electronics made easy by a new, no-maths Practical way Postal Instruction based on hosts of experiments and equipment buildings carried out at home. New courses bring enjoyment as well as knowledge of this fascinating subject.—Free brochure from Dept. W.W.122, Radiostructor, Reading [0240

PATENTS

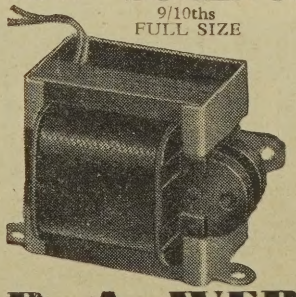
THE proprietor of British Patent No. 750436, entitled "Radio Navigation System," offers same for licence or otherwise to ensure practical working in Great Britain.—Inquiries to Singer, Stern & Carlberg, 140 So. Dearborn Street, Chicago, Illinois 60603, U.S.A. [1035

BOOKS

"INTRODUCTION to Valves." By R. W. Hallows, M.A.Cantab., M.I.E.E., and H. K. Milward, B.Sc.Lond., A.M.I.E.E. Describes the principles, construction, characteristics and uses of most types of radio valves. The approach is simple and, as far as possible, non-mathematical, but the book provides the student with a thorough understanding of valves and how they work. 8/6 net from all booksellers. By post 9/4 from Iliffe Books Ltd., Dorset House, Stamford St., London, S.E.1.

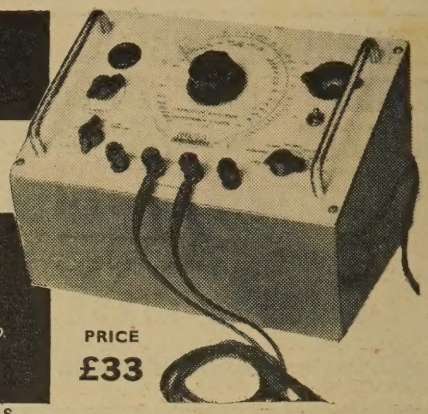
FOR ALL YOUR PANEL WORK WRITE FOR ILLUSTRATED BROCHURE OF PARALEX & LUFBRA ADJUSTABLE HOLECUTTERS
WITH MORSE TAPER SHANK UP TO NO. 4
OR STRAIGHT SHANK ⅜ DIA. TO ⅝ DIA.

HOLES ACCURATELY BORED FROM 1in. DIA. TO 12½in. DIA.
AKURATE ENGINEERING Co. Ltd.
CROSS LANE, LONDON, N.8
TEL. FITZROY 2670
14WW—192 FOR FURTHER DETAILS.

ACOUSTIC WADDING
As recommended by Goodmans for resonance damping.
"BONDACOUST" 5 yd. Roll **30/-** Carr. 4/-
10" wide 1" nominal thickness
"CELLOSENE" 5 yd. Roll **19/-** Carr. 4/-
40-ply (½" nominal thickness) 36" wide
Sole retail distributors
H. L. SMITH & CO. LTD.
287/289 EDGWARE ROAD, LONDON, W.2.
Telephone Paddington 5891/7595
RANGE OF **GOODMANS & WHARFEDALE** LOUDSPEAKERS ON DEMONSTRATION

A.C. SOLENOID TYPE SCM
9/10ths FULL SIZE

Continuous 3ozs. at ½".
Instantaneous to 2lbs.
Larger sizes available.
Also—Transformers to 7kVA 3 phase.
R. A. WEBBER LTD.
KNAPPS LANE, CLAY HILL, BRISTOL 5 Phone: 65-7228/9
14WW—193 FOR FURTHER DETAILS.

DEPENDABLE! ACCURATE! SIMPLE!

Capacitor Analyser & Resistance Bridge



F. C. ROBINSON & PARTNERS LTD.

Specialists in Electronic Equipment and Instrumentation

Works & Northern Sales
COUNCILLOR LANE, CHEADLE
CHESHIRE
Telephone: GATley 6511 (3 lines)

FCR

Southern Sales & Export
DAVIES HOUSE, 181 ARTHUR RD.
WIMBLEDON, LONDON S.W.19.
Telephone: WIMbledon 6386

PRICE £33

14WW—194 FOR FURTHER DETAILS.

INDEX TO ADVERTISERS

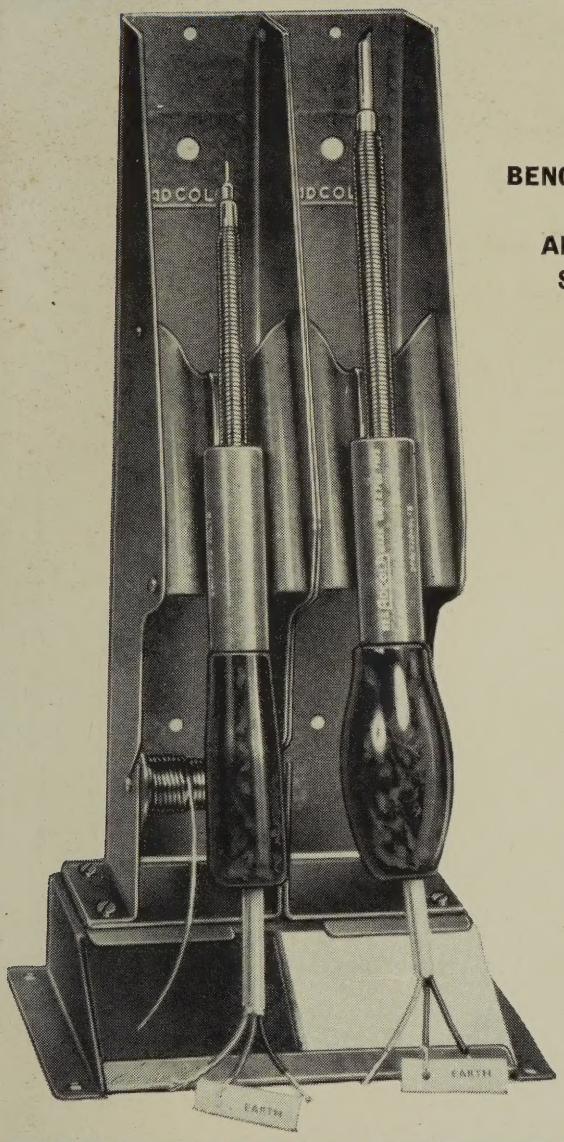
Appointments Vacant Advertisements appear on pages 131 to 139

	PAGE
Acoustical Mfg. Co., Ltd.	35
Adcola Products, Ltd.	Cover iii
A.D.S. Relays, Ltd.	87
Advance Electronics, Ltd.	18, 19, 45, 55
A.E.I. Cables, Ltd.	126
A.E.I., Ltd.	47
Aeon Laboratories, Ltd.	143
Airmec, Ltd.	50A, 50B, 64
Akurate, Eng. Co.	143
Alpha Radio Supply Co., Ltd.	120
A.M.F., Ltd.	48
Anders Electronics, Ltd.	4
A.N.T.E.X., Ltd.	33
A.P.T. Electronic Industries, Ltd.	53
Armstrong Audio, Ltd.	22, 61
Audix, B. B., Ltd.	141
Avo, Ltd.	1, 3
Avon Communications & Electronics, Ltd.	140
Avonlea, Ltd.	142
Baker's Selhurst Radio	122
Batey, W., & Co., Ltd.	54
Belling-Lee, Ltd.	73
Bentley Acoustic Corpn., Ltd.	118
Birmingham Sound Reproducers, Ltd.	39
Brenell Engineering, Ltd.	23
Britain, Chas., (Radio), Ltd.	91
British Communications Corpn., Ltd.	6
British Institute of Engineering Technology	52
British National Radio School	138
Brookes Crystals (1961), Ltd.	56
Bulgin, A. F., & Co., Ltd.	Edit. 591
Bullers, Ltd.	30
C. & N. (Electrical) Ltd.	86
Cannon Electric, Ltd.	90
Carr Fastener Co., Ltd.	62
Celestion, Ltd.	2
Chambers College	137
Clark, A. N., (Engineers), Ltd.	30
Clyne Radio, Ltd.	98, 99, 100
Concord Electronics	140
Cosmocord, Ltd.	72
C.R.E.I. (London)	63
Curson, B.W.	142
Daly Condensers, Ltd.	139
Davies, A., & Co.	142
Daystrom, Ltd.	11, 12, 13, 14
Denco (Clacton), Ltd.	88
Dependable Radio Supplies, Ltd.	140
Direct T.V. Replacements	88
Drake Transformers, Ltd.	17
Eitel-McCullough	40
Electro-Winds, Ltd.	143
Electronics (Croydon), Ltd.	119
Electrosil, Ltd.	83
Elliott Bros. (London), Ltd.	92
English Electric Valve Co., Ltd.	67
Enthoven Solders, Ltd.	8
Eon Products, Ltd.	86
Erie Resistor, Ltd.	9
ETA Tool Co., Ltd.	66
Ever-Ready Co. (G.B.), Ltd.	90
Ferranti, Ltd.	Cover ii
Ferrograph Co., Ltd.	31
Garrard Engineering, Ltd.	41
Gee Bros. (Radio), Ltd.	114
Gladstone Radio	112
Glaser, L. & Co., Ltd.	142
Goldring Mfg. Co., Ltd.	10
Goodmans Industries, Ltd.	16
Goodwin C. C. (Sales), Ltd.	140
Grampian Reproducers, Ltd.	62
Hall Electric, Ltd.	5
Harmsworth, Townley & Co.	66
Harris Electronics (London), Ltd.	122
Harris, P.	141
Harverson Surplus Co., Ltd.	126, 127
Henry's (Radio), Ltd.	102, 103
HCD Research, Ltd.	110
Hornton's Electronics	120
Howell's Radio	84
H.P. Radio Services, Ltd.	38
Hunt, A. H. (Capacitors), Ltd.	37
I.M.O. (Electronics), Ltd.	93
Impex Electrical, Ltd.	64
International Correspondence Schools	54, 112
J. & J. Electronics	135
J. T. Supply	142
K.E.F. Electronics, Ltd.	52
K.L.B. Electric, Ltd.	44
Kempner, S., Ltd.	58
Kenure, Holt & Co., Ltd.	140
Keyswitch Relays, Ltd.	7
Lasky's Radio, Ltd.	94, 95, 96, 97
Lawson Tubes	139
Leak, H. J., & Co., Ltd.	79
Ledon Instruments, Ltd.	110
Leevers-Rich Equipment, Ltd.	38
Levell Electronics, Ltd.	21
Lewis Radio Co.	130
Lexor Electronics, Ltd.	64
Light Soldering Developments, Ltd.	34
Linear Products, Ltd.	42
Lionmount & Co., Ltd.	110
London Central Radio Stores	141
Lyons, Claude, Ltd.	20, 59
Malvyn Engineering Works	142
Marconi Company, Ltd.	71, 74
Marconi Instruments, Ltd.	26, 27, 28
Marshall, A. & Son	134
Martin Electronics, Ltd.	120
McMurdo Instrument Co., Ltd.	46
Mills, W.	89
Minimitter (1964), Ltd.	54
Mobile Sales Co.	137
Modern Book Co.	130
Morhan Exporting Corpn.	60
Moss Watson Co.	142
M.R. Supplies, Ltd.	60
Mullard, Ltd.	70
Multicore Solders, Ltd.	130, Cover iv
Newport Instruments, Ltd.	143
Nicholls, E. R.	142
Nombrex, Ltd.	36
Olson Electronic, Ltd.	32
Orchard & Ind., Ltd.	38
P. & M. Service	136
Painton & Co., Ltd.	50
Partridge Transformers, Ltd.	62
P.C. Radio, Ltd.	121
Pembridge College of Technology	64
Philips N.V.	78
Peto-Scott Electrical Instruments, Ltd.	40
Pinnacle Electronic Products, Ltd.	15
Pitman, Sir Isaac, & Son, Ltd	126
Post Radio Supplies	143
Premier Radio Co.	98, 99, 100
Proops Bros., Ltd.	123
Pye Telcommunications, Ltd.	24, 25, 57
Quartz Crystal Co., Ltd.	140
R.C.A. (Great Britain), Ltd.	51
Raaco, Ltd.	90
Racal Engineering, Ltd.	65
Radford Electronics, Ltd.	56
Radio & T.V. Components (Acton), Ltd.	117
Radio Clearance, Ltd.	111
Radio Component Specialists	104, 105
Radio Exchange Co., The	110
Radiospares, Ltd.	32
Radiostructor	122
Radio Supply (M/c), Ltd.	106, 107, 108
Redifon, Ltd.	75
Reliance Gear Co., Ltd.	92
Relosound, Ltd.	85
Reproducers & Amplifiers, Ltd.	32
Robinson, F. C., & Partners, Ltd.	84, 144
Roburn Agencies, Inc.	56
Rollet, H., & Co., Ltd.	142
Ross, Courtney & Co., Ltd.	139
Samsons (Electronics), Ltd.	113
Service Trading Co.	108, 109
Scientific Products	143
Sifam Electrical Instrument Co., Ltd.	141
Sinclair Radionics	80, 81, 82
Smith, G. W. (Radio), Ltd.	101
Smith, H. L., & Co., Ltd.	42, 143
Smith, John, Ltd.	66
Sona Electronic Co.	124
Sound Coverage, Ltd.	84
South Supplies (Electrical), Ltd.	115
Southern Radio Supply, Ltd.	142
Spear Engineering Co., Ltd.	130
Specialist Switches, Ltd.	60
Stamford, A. L.	140
Steatite & Porcelain Products, Ltd	43
Stern-Clyne, Ltd.	98, 99, 100
Superior Electronics, Corpn.	34
Tannoy, Ltd.	142
Technical Trading Co.	134
Tektronix (U.K.), Ltd.	29
Telequipment, Ltd.	68
Thompson, A. J.	126
Thorn A.E.I. Radio Valves & Tubes, Ltd.	76
Thorn Electronics, Ltd.	49
T.R.S. Radio	125
Universal Book Co.	141
Valradio, Ltd.	58, 88
Vitality Bulbs, Ltd.	92
Vortexion, Ltd.	77
Watts, Cecil E.	141
Waveforms, Ltd.	142
Webber, R. A., Ltd.	143
Webb's Radio, Ltd.	118, 138
West Instruments, Ltd.	92
Weymouth Radio Mfg. Co., Ltd., The	36
Wharfedale Wireless Works, Ltd.	44, 46, 48
Whiteley Electrical Radio Co., Ltd.	58
Wilkinson, L. (Croydon), Ltd.	116
Wirecomp Electronics	112
Z. & I. Aero Services, Ltd.	128, 129

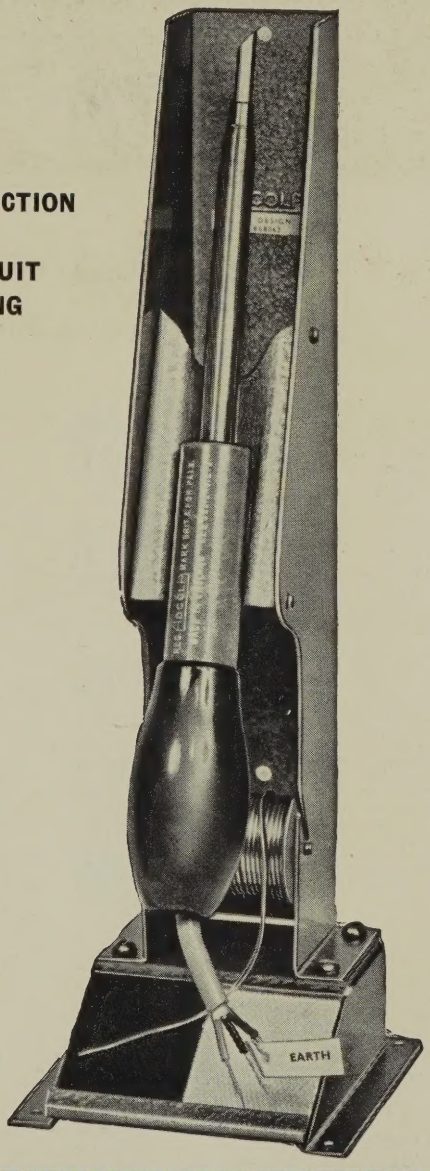
Printed in Great Britain for the Publishers, ILIFFE ELECTRICAL PUBLICATIONS LTD., Dorset House, Stamford St., London, S.E.1, by CORNWALL PRESS LTD., Paris Garden, London, S.E.1. *Wireless World* can be obtained abroad from the following: AUSTRALIA and NEW ZEALAND: Gordon & Gotch, Ltd. INDIA: A. H. Wheeler & Co. CANADA: The Wm. Dawson Subscription Service, Ltd.; Gordon & Gotch, Ltd. SOUTH AFRICA: Central News Agency, Ltd.; William Dawson & Sons (S.A.), Ltd. UNITED STATES: Eastern News Co., 306 West 11th Street, New York 14.

ADCOLA
PRODUCTS LIMITED
(Regd Trade Mark)
SOLDERING EQUIPMENT

DESIGNS GIVING
TOTAL PERFORMANCE



FOR
BENCH LINE PRODUCTION
&
AMATEUR'S CIRCUIT
SOLDER JOINTING



For full information apply direct to

HEAD OFFICE SALES & SERVICE
ADCOLA PRODUCTS LTD
ADCOLA HOUSE, GAUDEN ROAD,
LONDON, S.W.4.

Telephones: MACaulay 4272 & 3101 *Telegrams: SOLJOINT, LONDON, S.W.4*

AUSTRALIAN ASSOCIATES: ADCOLA PRODUCTS PTY LTD., 673 WHITEHORSE ROAD, MONT ALBERT, MELBOURNE
AGENTS IN ALL LEADING COUNTRIES

14WW—002 FOR FURTHER DETAILS.

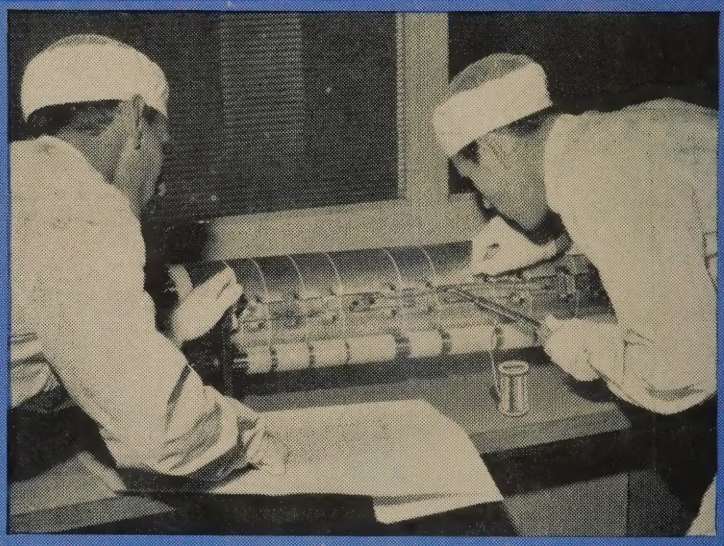
ERSIN Multicore SOLDER

UNDER THE SEA

Ersin Multicore Solder is made in Europe's largest cored solder factory, and contains only the purest tin and lead plus five cores of extra-active non-corrosive Ersin flux. It is undoubtedly the world's finest and most reliable cored solder. THERE IS AN ERSIN MULTICORE SOLDER FOR YOUR PURPOSE . . . whether it be the rapid soldering of miniature components by a production soldering process, or the individual production of large units of equipment such as fully transistorised submersible repeaters. Alloy, diameter of the solder, type and percentage of flux in the solder are all points to be considered.

For production soldering processes Ersin Multicore Solder with 362P Ersin flux in 60/40 and Savbit No. 1 alloys, and containing an exclusive agent Pentacol, promote the extra rapid spread of the lower percentage of flux in the cores—less fumes are liberated —less flux residue is left.

Multicore Savbit Alloy, to which a precise amount of copper is added prolongs bit life up to ten times, ensures more consistent soldered joints, and eliminates maintenance of soldering iron bits.



Ersin Multicore Solder is shown being used at the Erith factory of Submarine Cables Ltd., in the production of a submersible repeater designed to last for a minimum of 20 years under the sea without attention.

The life and reputation of any piece of electronic equipment can rest entirely on the solder used in assembly, a minute fraction of its cost. That is why the finest, most dependable cored solder is invariably the most economical and best. Ersin Multicore is the most widely used cored solder in the U.K. and is exported to over 50 overseas countries.

THERE IS AN ERSIN MULTICORE SOLDER FOR EVERY PURPOSE WHERE PRECISION SOLDERING IS REQUIRED

CMMS19

ERSIN Multicore SOLDER

Engineers and technicians are invited to write on their Company's letter heading for the completely revised 6th Edition of the 24-page booklet "MODERN SOLDERS" containing data on melting points, gauges, alloys, etc. Also, reprint of "Industrial Electronics" article "Erosion of Soldering iron bits", by P. Sharples.

MULTICORE SOLDERS LIMITED, MULTICORE WORKS, HEMEL HEMPSTEAD, HERTS. (BOXMOOR 3636)

14WW—003 FOR FURTHER DETAILS.